STATE OF CALIFORNIA

EDMUND G. BROWN JR.
Governor

Department of Alcoholic Beverage Control
Department of Corporations
Department of Financial Institutions
California Highway Patrol
California Housing Finance Agency
Department of Housing & Community Development
Department of Motor Vehicles
Department of Real Estate
Department of Transportation

BRIAN P. KELLY
Acting Secretary

Office of Real Estate Appraisers
Office of Traffic Safety
New Motor Vehicle Board
Board of Pilot Commissioners
California Film Commission
California Office of Tourism
Infrastructure and Economic Development Bank
Small Business Loan Guarantee Program
Public Infrastructure Advisory Commission

BUSINESS, TRANSPORTATION AND HOUSING AGENCY

July 1, 2013

The Honorable Mark DeSaulnier, Chair
Senate Transportation and Housing Committee
State Capitol, Room 2209
Sacramento, CA 95814

The Honorable Bonnie Lowenthal, Chair
Assembly Transportation Committee
1020 N Street, Room 112
Sacramento, CA 95814

The Honorable Mark Leno, Chair
Senate Committee on Budget and Fiscal Review
State Capitol, Room 5019
Sacramento, CA 95814

The Honorable Bob Blumenfield, Chair
Assembly Committee on the Budget
State Capitol, Room 6026
Sacramento, CA 95814

Dear Senator DeSaulnier, Senator Leno, Assembly Member Lowenthal, and Assembly Member Blumenfield:

This letter is to indicate that I have reviewed and approve the California High-Speed Rail Authority's (Authority) Greenhouse Gas Emissions Report as consistent with Provision 10 of Item 2665-306-6043 of the Budget Act of 2012 (SB 1029, Chapter 152, Statutes of 2012).

Sincerely,

BRIAN P. KELLY
Acting Secretary

Attachment

cc list: See next page

cc: The Honorable Darrell Steinberg, President pro Tem, California Senate
The Honorable John Pérez, Speaker, California Assembly
The Honorable Ted Gaines, Vice Chair, Senate Transportation and Housing Committee
Members of the Senate Transportation and Housing Committee
The Honorable Bill Emmerson, Vice Chair, Senate Budget and Fiscal Review Committee
Members of the Senate Budget and Fiscal Review Committee
The Honorable Eric Linder, Vice Chair, Assembly Transportation Committee
Members of the Assembly Transportation Committee
The Honorable Jeff Gorell, Vice Chair, Assembly Budget Committee
Members of the Assembly Budget Committee
Ms. Carrie Cornwell, Chief Consultant, Senate Transportation and Housing Committee
Mr. Ted Morley, Consultant, Senate Republican Caucus
Ms. Janet Dawson, Chief Consultant, Assembly Transportation Committee
Mr. Daniel Ballon, Consultant, Assembly Republican Caucus
Ms. Keely Bosler, Staff Director, Senate Budget and Fiscal Review Committee
Ms. Heather White, Budget Consultant, Senate Republican Caucus
Mr. Christian Griffith, Chief Consultant, Assembly Committee on the Budget
Mr. Chris Holtz, Budget Consultant, Assembly Republican Caucus
Ms. Diane Boyer-Vine, Legislative Counsel, State Capitol
Mr. Gregory Schmidt, Secretary of the Senate, State Capitol
Mr. E. Dotson Wilson, Chief Clerk of the Assembly, State Capitol

CALIFORNIA
High-Speed Rail Authority

July 1, 2013

The Honorable Mark DeSaulnier, Chair
Senate Transportation and Housing Committee
State Capitol, Room 2209
Sacramento, CA 95814

The Honorable Mark Leno, Chair
Senate Budget and Fiscal Review Committee
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1020 N Street, Room 112
Sacramento, CA 95814

The Honorable Bob Blumenfield, Chair
Assembly Budget Committee
State Capitol, Room 6026
Sacramento, CA 95814

Dear Senator DeSaulnier, Senator Leno, Assembly Member Lowenthal, and Assembly Member Blumenfield:

As you are aware, in 2006, the Legislature approved and Governor Schwarzenegger signed into law AB 32, the Global Warming Solutions Act, which called for the state to reduce Greenhouse Gas (GHG) emissions to 1990 levels by 2020, and then by 2050 to further reduce GHG emissions to 80 percent of 1990 levels. According to the California Air Resources Board's (CARB), 2008 Scoping Plan, the high-speed rail system is "one of the significant state projects," to make a positive contribution on the issue of global climate change.

The Budget Act of 2012 (SB 1029, Chapter 152, Statutes of 2012) laid the foundation for a statewide rail modernization program with parallel strategic investments in urban, commuter, and intercity rail systems which will provide improved connectivity to the high-speed rail system. In doing so, California's high-speed rail system will be an integral part of the development of sustainable communities. Linking intercity and urban commuter rail systems as part of sustainable community development will greatly improve the state's mobility and reduce greenhouse gas emissions and other pollutants.

As required under Provision 10 of Item 2665-306-6043 of SB 1029, the Authority shall "prepare and submit a report that provides an analysis of the net impact of the high-speed rail program on the state's greenhouse gas emissions."

The Authority's GHG report entitled, "Contribution of the High-Speed Rail Program to Reducing California's Greenhouse Gas Emission Levels," was completed in June 2013. The Authority found within this report, that after the Initial Operating Section (IOS) has begun its operation in 2022, the high-speed rail system will contribute to the reducing of GHG emissions every year. Within the very first year of operation, the direct emissions reduction would be equivalent of the GHG emissions created from the electricity used in 22,440 houses, or taking 31,000 passenger vehicles off the road. By 2030, after Phase 1 (San Francisco to Los Angeles) is operating, the system will have reduced GHG emissions between 4.5 and 8.4 million metric tons of greenhouse gasses (carbon dioxide equivalents), based on the low and high scenarios.

In addition, the Authority is committed to working to achieve zero net GHG emissions during construction by encouraging contractor energy efficiency and clean fleets, diverting construction waste from landfills, and investing in offset programs, such as urban tree planning.

For your review, attached is a copy of the Authority's complete GHG impact report. If you have any questions, please contact Matt Robinson, Deputy Director of Legislation, at (916) 324-1541 or matthew.robinson@hsr.ca.gov.

Sincerely,

Jeff Morales
Chief Executive Officer

Attachment

cc: The Honorable Darrell Steinberg, President pro Tem, California Senate
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Mr. Gregory Schmidt, Secretary of the Senate, State Capitol
Mr. E. Dotson Wilson, Chief Clerk of the Assembly, State Capitol

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Matthew Rodriquez
Secretary for
Environmental Protection

Edmund G. Brown Jr.
Governor

July 1, 2013

Mr. Dan Richards, Chairman
California High Speed Rail Authority
925 L Street Suite 1425
Sacramento, CA 95814

Dear Chairman Richards:

As you know, AB 32 is a key part of California's effort to grow our economy cleaner and more sustainably. One of the most important provisions of AB 32 is the requirement for the Air Resources Board (ARB) to develop a Scoping Plan. That plan, approved by ARB in 2008 and developed in close coordination with our sister agencies, describes a number of strategies that are designed to cut emissions, make our energy and transportation systems cleaner and more efficient, and drive investment in cleaner fuels and technologies.

The 2008 Scoping Plan included the high-speed rail system as part of the statewide strategy to provide more mobility choices and reduce greenhouse gas emissions. ARB is currently updating the Scoping Plan, which will include a discussion of the benefits of the high-speed rail system and the statewide rail modernization program.

As part of this effort, we appreciate the opportunity to review the High Speed Rail Authority's greenhouse gas Report to the Legislature. The Report provides an analysis of the net impact of the high speed rail system on the State's GHG emissions. Based on the ridership estimates included in the High Speed Rail Business Plan and other assumptions, we believe the analysis is reasonable, and the methodologies used for the analysis are consistent with the latest ARB emissions models.

The Authority's report specifically highlights estimated GHG emissions reductions achieved by the high-speed rail system as a result of offering mobility choices, and consequently decreasing vehicle miles traveled by passenger vehicle and airplane. Through investing in an integrated statewide rail system and clean vehicle technologies, the statewide rail modernization program will provide communities with lower carbon transportation options that both encourage sustainable community development and help reduce GHG and criteria pollutant emissions.

The analysis of GHG emission reductions in the Authority's report clearly demonstrates that the high-speed rail project will be an important part of meeting California's overall climate goals. This project will serve in the near term as the backbone of a more sustainable growth strategy in the San Joaquin Valley, and over time will provide a climate- friendly transportation option linking southern and northern California.

If you have any questions, please contact me at (916) 322-5840 or mnichols@arb.ca.gov .

Sincerely,

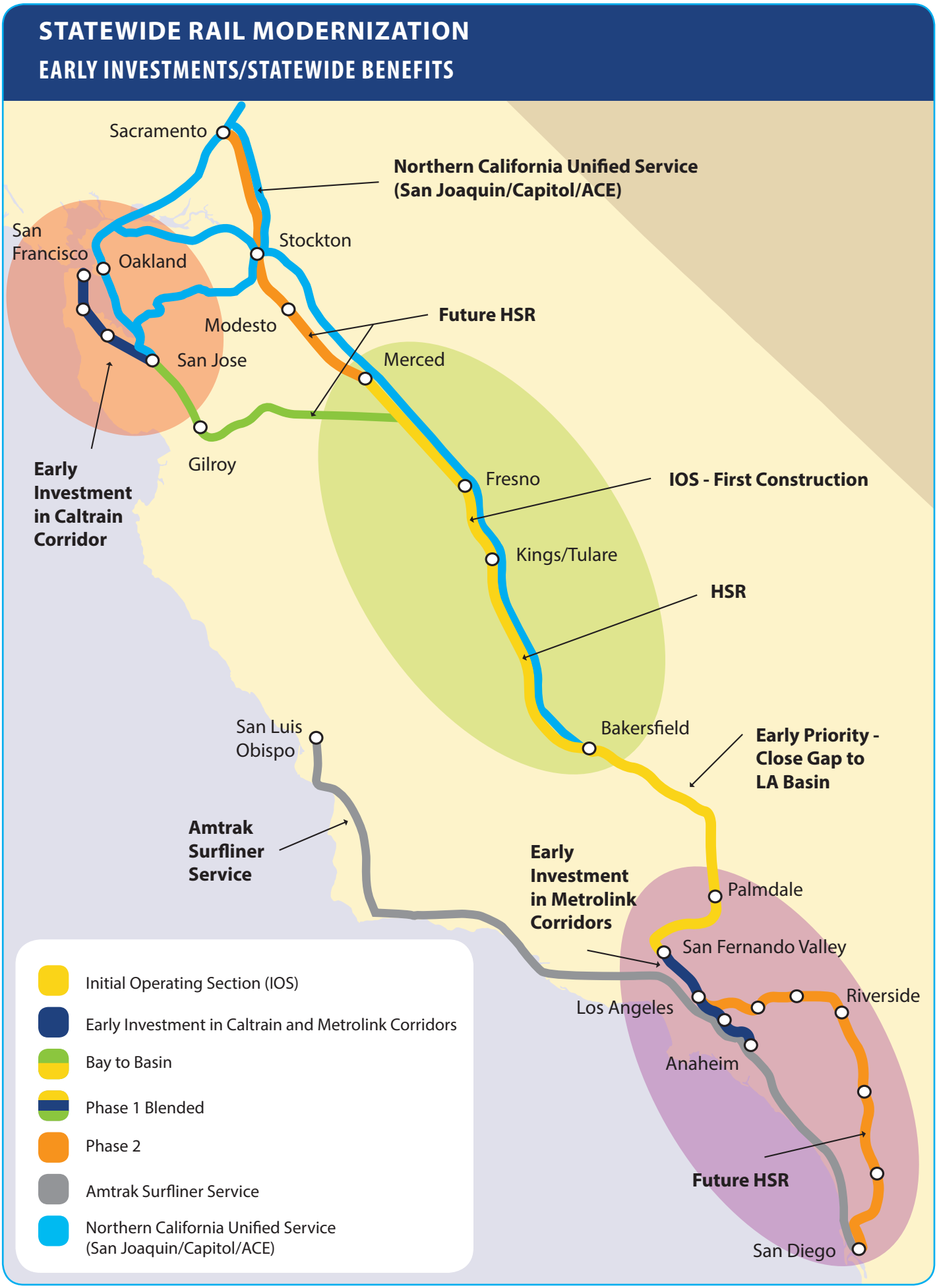
Mary D. Nichols
Chairman

CALIFORNIA
High-Speed Rail Authority

Contribution of the High-Speed Rail Program to Reducing California's Greenhouse Gas Emission Levels

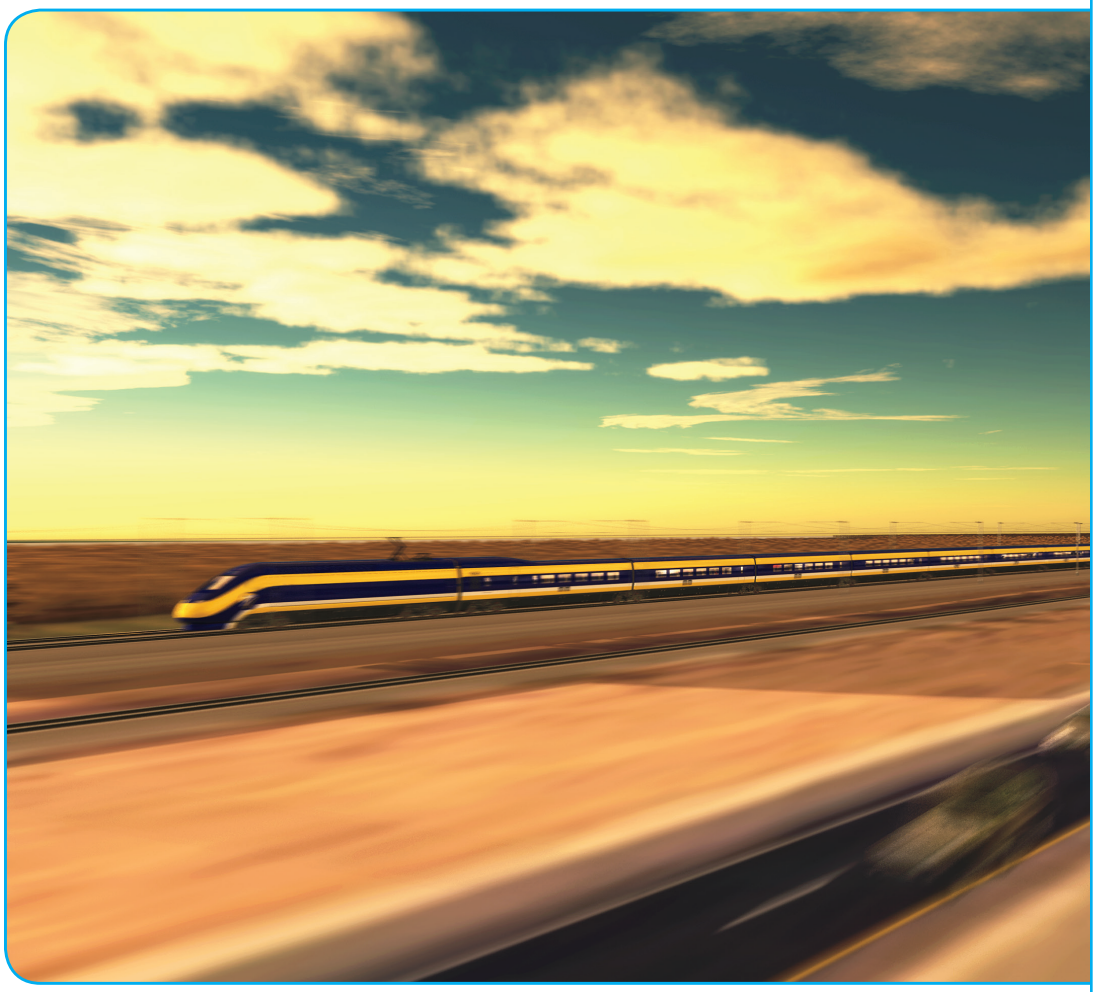
JUNE 2013

www.hsr.ca.gov


STATEWIDE RAIL MODERNIZATION
EARLY INVESTMENTS/STATEWIDE BENEFITS
Sacramento
Northern California Unified Service
(San Joaquin/Capitol/ACE)
San
Francisco
Oakland
Stockton
Modesto
Future HSR
San Jose
Merced
Early
Investment
in Caltrain
Corridor
Gilroy
Fresno
IOS - First Construction
Kings/Tulare
HSR
San Luis
Obispo
Bakersfield
Early Priority -
Close Gap to
LA Basin
Amtrak
Surfliner
Service
Early
Investment
in Metrolink
Corridors
Palmdale
San Fernando Valley
Riverside
Los Angeles
Anaheim
Future HSR
San Diego
Initial Operating Section (IOS)
Early Investment in Caltrain and Metrolink Corridors
Bay to Basin
Phase 1 Blended
Phase 2
Amtrak Surfliner Service
Northern California Unified Service
(San Joaquin/Capitol/ACE)

CALIFORNIA
High-Speed Rail Authority

The California High-Speed Rail Authority (Authority) is responsible for planning, designing, building and operating the first high-speed rail system in the nation. California's high-speed rail system will connect the mega-regions of the state, contribute to economic development and a cleaner environment, create jobs and preserve agricultural and protected lands. By 2029, the system will run from San Francisco to the Los Angeles basin in under three hours at speeds capable of over 200 miles per hour. The system will eventually extend to Sacramento and San Diego, totaling 800 miles with up to 24 stations. In addition, the Authority is working with state and regional partners to implement a statewide rail modernization program that will invest billions of dollars in urban, commuter, and intercity rail systems to meet the state's 21st century transportation needs.



California High-Speed Rail Authority

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- **Zero net greenhouse gas emissions during construction**
- **Using methodologies consistent with state practice, an estimated 4 to 8 million metric tons of CO2 saved by 2030, as if the state turned off a coal fired power plant**
- **Greenhouse gas savings from the first year of operations increasing to over 1 million tons of CO2 per year within 10 years**
- **Supportive transit and land use for greater cumulative benefits for the state**
- **Plans to plant thousands of new trees across the Central Valley**
- **Cleaner school buses and water pumps in Central Valley communities**
- **Agricultural conservation measures aimed at reducing Central Valley sprawl and preserving valuable agricultural land**
- **Significant contributions to the State's goals embodied in AB 32 and SB 375**
- **Strict guidelines for sustainability best practices for design-build contracts to minimize impacts and improve air quality.**
- **Result in net GHG emissions diversions that, conservatively, are the equivalent of the GHG emissions created from the electricity used in 22,440 houses, or removing 31,000 passenger vehicles from the road**

Net GHG Emissions

INTRODUCTION

Pursuant to Item 2665-306-6043, Provision 10 of the Budget Act of 2012 (SB 1029), the California High Speed Rail Authority (Authority) is required to submit to the Legislature a report on the "net impact of the high-speed rail program on the state's greenhouse gas emissions" by June 30, 2013. The following report details the projected net greenhouse gas (GHG) emissions associated with the construction and operation of the high-speed rail system. The Authority consulted with staff at the California Air Resources Board (ARB) and the California Energy Commission (Energy Commission) to review and confirm the assumptions, models, and methodologies used to prepare this report.

While the GHG emission reductions quantified in this report are those directly related to the high-speed rail project, the GHG benefits to the state go well beyond the project's direct contributions. The high-speed rail project is one element of a larger statewide rail modernization program designed to change the way people travel throughout the state, promoting sustainable, transit-oriented land-use choices that encourage active transportation and decrease the number of single-occupancy vehicle trips. As part of this statewide rail modernization program, significant investments are being made in intercity, commuter, and urban rail systems throughout California to provide connectivity to the high-speed rail system, making it easier for riders to access alternative modes of transportation. Additionally, as is the case with the electrification of Caltrain, the high-speed rail program will result in cleaner, more efficient rail travel in California, as existing systems integrate with high-speed rail.

The California High-Speed Rail Authority is committed to helping reshape the state's transportation future. The Authority has worked with state and local agencies to develop planning tools, such as Vision California[A] and Urban Footprint[B], to help cities and counties plan for future high-speed rail service. The high-speed rail system, in conjunction with the state's sustainable communities goals, is being utilized as a means of inhibiting sprawl and reducing congestion on roadways. The system, as a stand-alone project, has significant GHG benefits as detailed in this report. However, when combined with additional investments in transportation and sustainable community development, the system's cumulative benefits are far greater.

[A] 2012 Business Plan, Page 1-11, www.visioncalifornia.org

[B] www.visioncalifornia.org

BACKGROUND

The Global Warming Solutions Act of 2006 (AB 32, Nunez, Statutes of 2006), requires the state to reduce GHG emissions to 1990 levels by 2020, and to further reduce emissions beyond 2020, which was quantified as 80 percent of 1990 levels by 2050 through Executive Order S-3-05 (2005). Additionally, AB 32 requires ARB to prepare and periodically update a Scoping Plan which outlines the approach the state will take to meet the GHG emission reduction goals. Although the primary purpose of the high-speed rail system is to provide high-quality interregional transportation, a compound benefit of the system is a reduction in GHG emissions. Because of the high-speed rail system's environmental benefits, it was included in the 2008 Scoping Plan as "part of the statewide strategy to provide more mobility choice and reduce greenhouse gas emissions."

This report describes a project GHG emissions inventory that is based on the best available data for California and most applicable methods. It lays out qualitative and quantitative GHG emissions reductions associated with planned mitigation activities and rail modernization projects, as well as compound GHG benefits resulting from the high-speed rail program.

The Authority recognizes the importance of delivering this major infrastructure project in a sustainable manner and is committed not only to clean, renewable energy for system operation, but also to mitigating identified environmental impacts during construction.

The Authority's 2012 Business Plan, released in April 2012, identifies a phased implementation strategy for constructing and operating the high-speed rail system. The phased implementation strategy begins with the development of a 300-mile long Initial Operating Section (IOS) through the Central Valley to the San Fernando Valley by 2022. Once this section is complete, the project will then connect the Central Valley to the San Francisco Bay Area to complete the "Bay to Basin" phase of the system, and the implementation of the Phase 1 Blended system connecting the San Francisco Bay area and Southern California by 2029. Starting with the IOS, the high-speed rail system will be integrated, or "blended" with existing rail and transportation infrastructure in both the Los Angeles Basin and the San Francisco Bay Area (Bookends). The 2012 Business Plan outlines early investments in the Bookend systems, as part of a statewide rail modernization program, including the electrification of Caltrain and enhancements to the Metrolink corridor between Palmdale and Anaheim, that ultimately lead to connectivity to the high-speed rail system, earlier benefits to commuters and the environment, and help increase ridership. SB 1029 appropriates $1.1 billion for the projects in the Bookends.

In addition, as part of a statewide rail modernization program, SB 1029 invests approximately $819 million in existing urban, commuter, and intercity rail systems throughout the state, including the Central Subway project in San Francisco, new rail cars for the Bay Area Rapid Transit (BART) system, the Regional Rail Connector in Los Angeles, and an upgrade of the Blue Line light rail system in San Diego. These investments will connect existing transportation systems to the high-speed rail system to provide an integrated rail network that will serve as a viable alternative to vehicle and air travel.

For this report, reviewed byARB, and the project in general, the Authority followed a methodology in reporting GHG emissions based on the Climate Registry General Reporting Protocol[1]. This is a widely used and recognized methodology, or protocol, for quantifying GHG emissions from an organization or from a specific project. The Climate Registry is a nonprofit collaboration among several US and Mexican states, as well as Canadian provinces, territories and Native Sovereign Nations[2], that sets consistent and transparent standards to calculate and verify GHG emissions and have them publicly available in a centralized registry. Additionally, the Authority referenced the Council on Environmental Quality (CEQ) and the American Public Transportation Association (APTA) guidance informing project-level benefit estimations for rail projects. This report quantifies GHG emissions displaced by the high-speed rail system from reducing automobile and plane travel, direct GHG emissions associated with construction and operation of the high-speed rail system, and qualitative descriptions of potential upstream GHG emissions associated with the production of infrastructure materials. For this report, the Authority will also discuss an estimate of the direct GHG emissions sequestered through specific offset projects, such as urban greening, or sequestered or offset through required mitigation activities during construction, such as engine efficiency requirements.

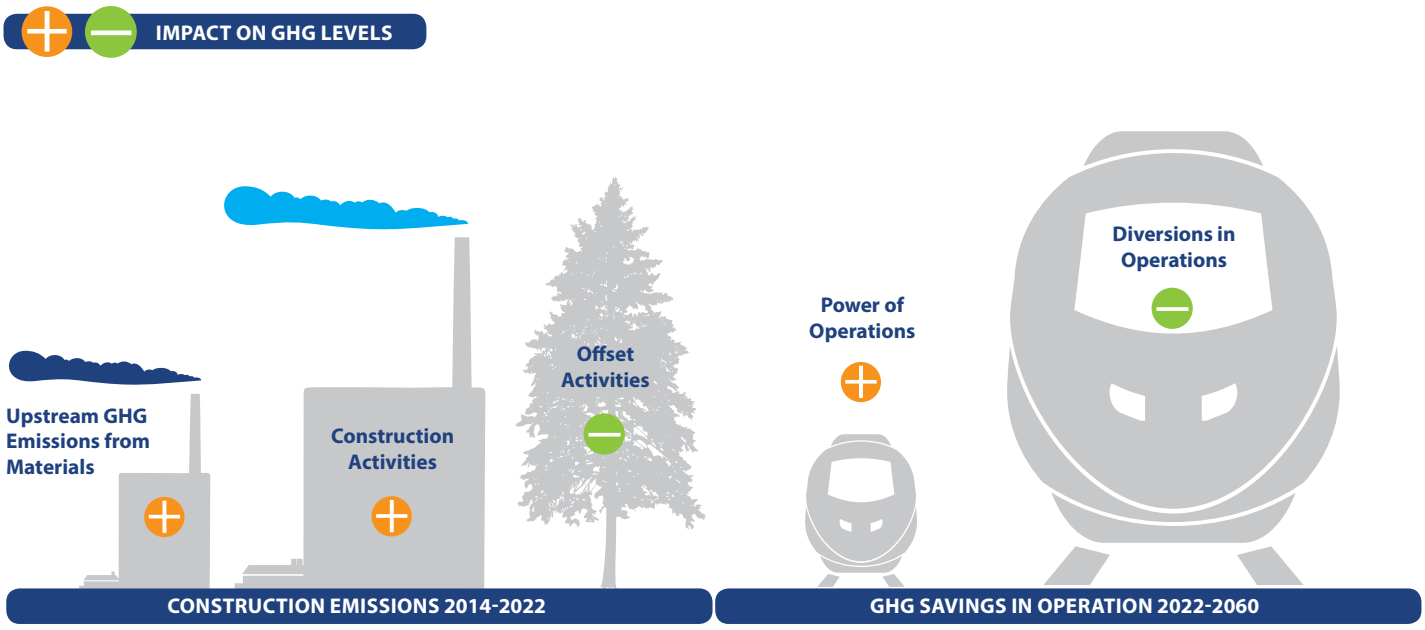
[1] Climate Registry: General Reporting Protocol, Version 2.0. March 2013.

[2] A detailed list of Climate Registry members can be found here *http://www.theclimateregistry.org/members/*

RESULTS

Using the data sets, models, and assumptions discussed later in *Detailed Methodology: Models and Data Sets*, the Authority calculated the GHG emissions reductions associated with mode shift from cars and planes to the high-speed rail system (Vehicle Miles Traveled (VMT) reduction and air travel reduction), the GHG emissions associated with the use of electricity to power operations (traction power and facilities), the GHG emissions associated with construction activities, and the GHG emissions potentially sequestered through offset activities. The diagram below presents a schematic representation of the major GHG emissions sources, credits, and debits for the high-speed rail system from the start of construction through operation.

GHG EMISSIONS SOURCES FOR HIGH-SPEED RAIL SYSTEM



GHG EMISSIONS SAVINGS DURING OPERATIONS

The high-speed rail system begins reducing emissions in 2022, its first year of operation, as Californians switch from driving or flying to taking the train. Ridership increases as the system is expanded and as population grows, as discussed in the 2012 Business Plan. Net GHG emissions savings in operation are a product of the GHG emissions debits generated from power production to run the high-speed rail system subtracted from the GHG emissions credits that result from reducing VMT and air travel. As discussed in Detailed Methodology: Models and Data Sets of this report, the assumption for power emissions is that the Authority has purchased a renewable power mix of 20 percent solar, 40 percent wind, 35 percent geothermal, and 5 percent biogas converted to electricity. The Authority is committed to running the system on 100 percent renewable energy, and has worked with state partners such as the Energy Commission to gain knowledge on the use and availability of renewable energy to supply the system's needs over the life of the project. In addition, the Authority issued a Call to Industry[3] to collect initial information on renewable energy opportunities in the State of California to power the high-speed rail system.

In the table below, the annual GHG emissions reductions forecasted for the years 2022, 2026, 2029, 2035, and 2050 are reported. These years reflect the milestones identified in the 2012 Business Plan and correspond to when the specific phases of implementation are introduced. In addition, later years are presented as the points at which the system reaches steady state ridership, or correspond to California milestones. In the table below, GHG savings are presented as both a "high" and "low" as GHG savings are directly related to ridership. Higher ridership means greater GHG emissions savings. The explanation for high and low ridership scenarios is discussed in detail in the 2012 Business Plan, but in summary the ridership high and low scenarios are driven by "optimistic" and "pessimistic" assumptions about forecasts of socioeconomic conditions and other input variables[4].

Using the data from the table below, in 2022, the first year the system is operating, it will result in net GHG emissions diversions that, conservatively, are the equivalent of the GHG emissions created from the electricity used in 22,440 houses, or removing 31,000 passenger vehicles from the road. That amount of passenger vehicles is the same as one lane of traffic, almost 100 miles long. As reported above, under the more optimistic 'high' scenario, the

CO2E SAVINGS FROM HIGH-SPEED RAIL OPERATION

	2022 Initial Operating Section	2026 Full Ridership for the IOS	2029 Phase 1 Blended Service Begins	2035 Full Ridership for Phase 1 Blended Service	2050 Phase 1 Blended Service
High	0.33	1.05	1.40	1.85	1.99
Low	0.16	0.55	0.79	1.15	1.24

(million metric tons/year)

[3] Call to Industry: Sourcing Renewable Power Supplies for California High-Speed Rail. California High-Speed Rail Authority. April, 2013.

[4] See Chapter 5 of the 2012 Business Plan for more details: *http://www.hsr.ca.gov/docs/about/business_plans/BPlan_2012Ch5_RidershipRev.pdf*

results would be double. By 2026, the high-speed rail system would save the equivalent of 7,000 tanker trucks of gasoline by diverting between 0.55 and 1.05 million metric tons CO2e.

Adding the GHG emissions reductions from each year of operation, cumulatively, by 2030, the high speed rail system would divert between 4.5 million and 8.4 million metric tons of CO2e based on the low and high scenarios. That is the equivalent of the GHG emissions from a coal-fired power plant, or 488 million gallons of gas consumed, or would be as if a 500-mile lane of auto traffic were removed from the road. By 2050, cumulatively, the high-speed rail system would divert at least 27.1 million and possibly as much as 44.9 million metric tons of CO2e.

Even greater is its contribution as a part of the range of transportation solutions the state has focused on to achieve GHG emissions reductions[5]. It is important to keep in mind that the high-speed rail system, when combined with integrated transportation systems and better land-use decisions, achieves compound GHG emissions reductions greater than those listed in the table above. As explained by the ARB, these solutions together are all necessary to reach the 2050 goal[6].

More details about the specific investments in transit and rail projects and planning that support the high-speed rail system and have a GHG emissions reduction benefit, are discussed below.

STATEWIDE RAIL MODERNIZATION PLAN

The 2012 Business Plan identified a phased and blended implementation strategy for deployment of the high-speed rail system, including seamlessly combining operations of the high-speed rail system with existing commuter rail and high-capacity transit in northern and southern California. To achieve that goal, the Authority is working with state and regional partners to upgrade and seamlessly connect other transit and rail networks with the high-speed rail system to create and reinforce clean transportation options for Californians. This would involve many potential investments including high-speed rail, mass transit, active transportation, transit-oriented development, and promoting sustainable communities. The high-speed rail system is not a stand-alone measure, but is part of an integrated approach to address mobility and GHG emissions reductions through the transformation of California's transportation system.

Electrification of Caltrain

The Rail Modernization Program includes connectivity and bookend funding to the Caltrain system for the purposes of electrifying it between San Jose and San Francisco. The preliminary estimated GHG emissions reductions from switching out diesel trains with electric vehicles and installing positive train control systems is approximately 18,000 metric tons of CO2 annually.[7] Caltrain will be performing an updated calculation and have results available mid-2013. Ridership increases resulting from travel times savings would result in still greater GHG emissions reductions.

[5] Scoping Plan. ARB. 2008.

[6] Cap-and-Trade Auction Proceeds Investment Plan: Fiscal Years 2013-14 through 2015-16. ARB. May 14, 2013.

[7] Included in Authority's figures.

[8] HSR Report: France. SPUR. Emily Ehlers. July 2010.

Investment in Supportive Transit and Passenger Rail Systems

To date, connectivity funds, appropriated by the Legislature in SB 1029, have been allocated to projects throughout the state, including station and system improvements, vehicle upgrades, and major infrastructure projects, such as the Central Subway project in San Francisco. While the outcome of these projects may not be quantifiable in terms of GHG emissions reduced at this time, qualitative improvements can be assessed. For example, new or upgraded vehicles often have more modern technologies that emit fewer GHGs per mile of travel than do older or conventional vehicles. Other types of capital improvements, including renovating stations or installing advanced signaling systems, can enhance the customer experience in terms of comfort, improved reliability, and safety, which can be drivers for retaining existing passengers and attracting new ones. In addition to the range of benefits stemming from these improvements, the implementation of high-speed rail service with direct connection to other rail providers will further increase ridership on those services and compound GHG emissions reductions.

Station Communities

The high-speed rail system will provide a new sustainable transportation choice and through strategic, multi-modal station locations, support California's land-use objectives outlined in the Sustainable Communities and Climate Protection Act of 2008 (SB 375, Steinberg, Statutes of 2008) as well as AB 32. High-speed rail system stations around the world have been shown to be an effective and powerful tool to encourage sustainable, compact mix-use land development and pedestrian-oriented design while minimizing impacts to the natural environment. Two French cities, Lilles and Nantes, provide examples of how a combination of high-speed rail investment and local planning and development incentives can play a huge role in sparking station area development. Lille diversified into knowledge-intensive, service-producing activities once it was connected via high speed rail to London, Paris and Brussels. High-speed rail investment helped the city turnaround from depopulation and declining economic sectors. After being connected to high-speed rail in 1981, Nantes has evolved from an industrial port to a major service sector hub and one of the world's most livable cities.[8] The City of Fresno has already approved a land-use scenario that directed growth to infill and denser development within the downtown core, a scenario that should result in greater economic and environmental benefit. Compact, mixed-use development will not only support ridership for the high-speed rail system, but the 600 planned residential units and 460,000 square feet of commercial space minimizes pressure on more remote parcels and impacts to agricultural land. The Fulton Corridor Specific Plan market analysis estimated that the plan area, immediately adjacent to the Fresno high-speed station, had the potential for between 4,000 and 7,000 residential units by 2035.

Through linkage with local and regional transit and airports, high-speed rail stations can serve as a multi-modal transportation hub reducing automobile dependency. High-speed rail stations can help to stimulate economically vibrant downtown environments which, in turn, promote active transportation, such as walking and biking.

To help communities work to develop mutually beneficial solutions, the Authority is partnering with station cities and providing support for Station Area Planning, funded by both Proposition 1A and the American Recovery and Reinvestment Act, and planning tools to assist in the development of supportive land use or zoning requirements, including transit orientated development. Establishing transit orientated land uses is a strong part of long-term system ridership. Promoting viable alternatives to the single occupant vehicle, combined with denser land use patterns are fundamental elements of SB 375's Sustainable Community Strategy. To date, the Authority has entered into a funding agreement with the City of Fresno, and is finalizing funding agreements with the cities of Merced, Gilroy, San Jose, and Palmdale.

CONSTRUCTION GHG EMISSIONS CREDITS AND DEBITS

The Authority is committed to achieving zero net GHG emissions related to construction activities. While construction activities will generate GHG emissions, when coupled with the Authority's strategy, the result is zero net direct construction GHG emissions. For example, the estimated GHG emissions associated with construction activities, materials deliveries, and worker travel for Construction Package 1 (CP1), the first 29-mile construction segment of the high speed-rail system from Madera to Fresno, of 30,107 metric tons of CO2e, from 2013 to 2018, would be offset at the start of construction through a tree planting program that the Authority is developing. This multi-faceted forestry program will introduce enough trees into the region where construction is taking place to honor the Authority's commitment to offset the direct GHG emissions associated with construction. The program is planned to include urban forestry and tree planting, through regional tree foundations, which compounds GHG emissions reductions by providing shade and other amenities with tangible local economic benefits. The program could also include providing shade trees to interested home owners.

In addition, in the Request for Proposals[9] (RFP) for CP1, the Authority required contractors to recycle 100 percent of concrete and steel from construction and demolition activities, and to divert 75 percent of non-hazardous waste from landfills. A rough estimate, derived from the U.S. Environmental Protection Agency (US EPA) emissions equivalency calculator, is that diverting 100,000 tons of construction waste from a land fill would yield 265,000 metric tons CO2e of savings by reducing waste volumes in landfills, depending upon the precise mix of the waste stream and whether it is reused or recycled.

To positively affect construction GHG emissions further, the Authority is requiring;

- **All contractors to reduce energy use on site**
- **Increase energy and fuel efficiency through energy efficient on- and off-road equipment**
- **Use of recycled materials**
- **Minimizing water use**
- **Consider cost-effective renewable energy**

[9] Request for Proposals for Design-Build Services for Construction Package 1, Book 2, Part B: General Provisions. California High Speed Rail Authority. March 2012.

These requirements will be a part of the final contract requirements for the CP1 design-build contractor and subsequent contractors. The contractors will also be directed to explore methods to reduce the amount of potable water used onsite. These practical activities, including anti-idling programs, water efficiency, energy efficiency, and the use of fuel-efficient vehicles are among those that have been proven effective for reducing both GHG emissions and costs on many infrastructure projects. For example, at Chicago's O'Hare Airport, fuel efficient equipment is required for construction, and the contractor fleet must be able to use alternative fuels[10]. In particular, deploying fleets with the cleanest available engines, according to the non-road diesel emissions standards enforced by US EPA, is the one of the most significant means to reducing site emissions[11].

Regarding the construction materials, for some it is possible to calculate the impacts over the material's life-cycle, from extraction through processing, use onsite, and disposal, and express those impacts in GHG emissions terms. Those GHG emissions are usually the reporting responsibility of the manufacturer, and in terms of a project GHG emissions inventory, happen "upstream" and outside the boundary of the project. For example, cement manufacturers in California are subject to ARB's Mandatory Reporting and Cap-and-Trade Regulations. These regulations require cement manufacturers to report their GHG emissions annually to ARB. The emissions from cement manufacturing count towards the statewide GHG emissions "cap". The GHG emissions covered under the "cap" are required to be reduced through emission controls or a limited amount (eight percent) may be offset through the purchase of ARB certified offset credits.

However, the Authority considers it important to disclose the GHG emissions that occur outside of the project associated with materials used during construction. These have not yet been quantified, due to the limitations of available information at this stage of project delivery. While it is understood that the rail infrastructure will consist, largely of aggregate, concrete, steel, rails, and ballast; the precise source and supplier of those materials is not yet known. Additionally, the precise quantities are not available, given the nature of the design-build procurement process which involves development of concept-level designs which are then taken to final design and construction by a design-build contractor. For example, in April 2013, an apparent best-value design-build contractor was identified for CP1. The design-build contractor will execute final design, including determining a concrete mix fit for purpose of the project. And while the design-build contractor has estimated supply sources and locations to develop their cost estimate; final sources, locations and quantities will be determined over the course of construction.

This information will be collected throughout the delivery of CP1. In the RFP, the Authority required contractors to track and report materials quantities and deliveries, fuel, water and electricity use on site, recycling and reuse volumes, and diesel emissions. This information will provide a baseline for GHG emissions to inform subsequent procurement documents to reduce construction GHG emissions where possible and feasible.

Further, for CP1, the Authority has exercised the activities within its control to minimize the GHG emissions associated with the materials used in the project. The Authority directed

[10] Making Our Airports Aspirational: A Sustainable Path. Chicago Department of Aviation. 2012.

[11] Massachusetts Department of Transportation Diesel Retrofit Program for Non-road Construction Equipment. Kasprak, Alex. July 29, 2011.

the contractor to explore use of recycled materials such as tire-derived aggregate, fly ash, and aggregates in the construction of the infrastructure. Those materials have been proven in operation of high-speed rail passenger service and meet the strength, durability, and maintainability performance requirements of the project.

Finally, several elements of the high-speed infrastructure will be roadway infrastructure, completed according to California Department of Transportation (Caltrans) specifications. These specifications include guidance on the use of supplementary cementitious materials for Caltrans facilities. For project managers concerned with reducing the impact of materials used, while still using materials proven fit for purpose, allowing the use of recycled content, specifying construction waste diversion, and minimizing packaging and transport distance, collectively form a network of specification, policy, and contract requirements that achieve minimization of GHG emissions during construction.

OTHER OFFSETS FROM HIGH-SPEED RAIL IMPLEMENTATION

ENVIRONMENTAL MITIGATION AND FARMLAND PROTECTION

The Authority is committed to mitigating the impacts of the project in the Central Valley and protecting and preserving important farmland. To that end, the Authority is entering into an agreement with the California Department of Conservation (DOC) and the Madera and Merced County Farm Bureaus to assist in obtaining farmland conservation easements from willing sellers located near the high-speed rail alignment between Merced and Bakersfield. A conservation easement is a voluntary, legally recorded deed restriction that is placed on a specific property used for agricultural production. The goal of an agricultural conservation easement is to maintain agricultural land in active production by removing the development pressures on the land[12]. Over time, the agreement with DOC will likely be expanded to address project-related impacts to agricultural lands in other portions of the San Joaquin and Sacramento Valleys, including the area between San Jose and Merced and between Merced and Sacramento. The establishment of conservation easements and the implementation of other mitigation measures will result in thousands of acres of farmland and wildlife habitat protected from future development. Saving agricultural land from development results in GHG emission reduction benefits, with the amount varying by the type of agricultural practices.

In addition, the Authority is entering into an agreement with the San Joaquin Air Pollution Control District to improve air quality during construction for certain criteria air pollutants. This Voluntary Emissions Reductions Agreement involves the Authority providing funds for the replacement of irrigation pumps, buying new school busses, retrofitting old truck engines, and other similar projects. Through this, the Authority will zero out construction air quality emissions (particulate matter and volatile organic compounds), while schools, farms, and irrigation districts in the Central Valley will have clean, new equipment, that will last beyond the high-speed rail construction timeframe. The replacement of fossil fuel burning irrigation pumps with electric pumps, and the replacement of, or retrofit of vehicles with more efficient engines have a GHG emissions benefit that will be calculated once the final set of replacements is determined in late 2013.

[12] Agricultural Land Conservation Easement FAQ. State of California Department of Conservation. May 2013.

DETAILED METHODOLOGY: MODELS AND DATA SETS

GASES INCLUDED IN THE PROJECT INVENTORY

California's GHG emissions program covers all six major GHGs recognized under the Kyoto Protocol. The Kyoto Protocol is a legally-binding, international agreement linked to the United Nations Framework Convention on Climate Change, which commits its parties to binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on December 11, 1997 and entered into force on February 16, 2005. It is the most widely adopted GHG emissions reduction commitment, and is regarded as the critical first step toward achieving a tangible, global reduction framework to stabilize atmospheric concentrations of GHG emissions.[13]

- **Carbon Dioxide (CO2)**
- **Methane (CH4)**
- **Nitrous Oxide (N2O)**
- **Hydrofluorocarbons (HFCs)**
- **Perfluorocarbons (PFCs)**
- **Sulfur Hexafluoride (SF6)**

Each gas has a particular Global Warming Potential (GWP), described in terms of carbon dioxide equivalents (CO2e), as noted below.

For example, nitrous oxide's global warming potential is 310, meaning a unit mass of nitrous oxide warms the atmosphere 310 times more than a unit mass of carbon dioxide. These factors allow for a simplified reporting of greenhouse gas emissions collectively as CO2e.

GLOBAL WARMING POTENTIAL (GWP)		
GREENHOUSE GAS	**MAJOR SOURCE**	**CO2E FACTOR**
Carbon Dioxide (CO2)	Combustion of fossil fuel, burning trees and solid waste, industrial manufacturing	1
Methane (CH4)	Landfills, agricultural sources, production and transport of fossil fuels	21
Nitrous Oxide (N2O)	Combustion of transportation fuels, fertilizer manufacture and other agricultural sources, ammonia production	310
Hydrofluorocarbons (HFCs)	Refrigerants, substitution of ozone depleting substances	150-11,500
Perfluorocarbons (PFCs)	Semi-conductor manufacturing, aluminum production	6,500-9,200
Sulfur Hexafluoride (SF6)	Electricity transmission and distribution, magnesium production	23,900
(NACAA, 2011; ARB)		

[13] United Nations Framework Convention on Climate Change. *http://unfccc.int/kyoto_protocol/items/2830.php May 2013.*

Per the protocol, GHG emissions are reported, in this report, in terms of carbon dioxide equivalent (CO2e), when a calculation involves multiple gasses. Carbon dioxide, methane, and nitrous oxide are the gasses relevant to the activities analyzed. When only carbon dioxide emissions are associated with a particular activity, both carbon dioxide (CO2) and CO2e are reported.

Large-scale GHG emissions are commonly expressed in metric tons. For context, one metric ton of carbon dioxide equivalent is equal to the GHG emissions from 112 gallons of gasoline, or one acre of forest in the US sequesters one metric ton of carbon. The table below contains additional context.

ACTIVITY TYPES

The project inventory accounted for several types of activity in construction and operation, including mitigation and offset activities, based on what is currently known concerning construction means and methods and operation of the high-speed rail system.

Construction activities associated with the rail system that directly produce GHG emissions include mobile source emissions from construction equipment (fuels combusted in trucks and equipment actively constructing the project) and mobile source emissions from vehicles delivering materials to the project site. Mobile source emissions from worker travel to the site are also included. Activities to construct the high-speed rail system will consist of earthwork and other major civil construction activity for at-grade, elevated, and retained fill rail segments, roadways, and roadway overpasses. These activities account for

GHG IN GENERAL TERMS
One passenger vehicle in one year: 5 metric tons
One home's electricity for one year: 7 metric tons
One tanker truck of gasoline: 80 metric tons
One railcar of coal: 225 metric tons
(U.S. Environmental Protection Agency, Greenhouse Gas Equivalencies Calculator (Referenced May 2013))

the vast majority of earthwork, the largest amount of diesel-powered off-road construction equipment, and the majority of material which is to be hauled along public streets. The timeframe and activities analyzed and discussed in this report were for CP1. As the project moves forward, direct GHG emissions calculations will be carried out for each subsequent construction package.

During operation, GHG emission reduction benefits are the result of passengers choosing to ride the high-speed rail system rather than using automobiles and airplanes to travel. In addition, indirect GHG emissions are associated with the production of electricity needed to run the electrified rail system and facilities. The Authority plans to purchase 100 percent renewable power for these purposes. The duration of the analysis for these activities was 2022 to 2060.

MODELS, DATASETS, AND ASSUMPTIONS

As noted by the ARB, project GHG emissions inventories always reflect the best available data, assumptions, and models at the time of analysis. Models and data sets have been refined and analysis assumptions have evolved since the 2012 Business Plan, and the Authority has updated its GHG emissions calculations for the high-speed rail system accordingly for this report. Similarly, the GHG emissions calculated for CP1 will be updated prior to construction.

HOW CONSTRUCTION EMISSIONS ARE CALCULATED

The initial GHG emissions estimate for CP1 consisted of GHG emissions from off-road equipment used to build the infrastructure, GHG emissions from on-road vehicles transporting workers or material, and used load factors to account for the actual performance of equipment in the field. Load factors are the ratio of average equipment horsepower used compared to maximum equipment horsepower.

Construction emissions were calculated using the URBan EMISsions (URBEMIS) 2007 model. URBEMIS 2007 uses emission factor data for off-road equipment based on data from two ARB models: OFFROAD 2007 and EMission FACtor (EMFAC) 2007. The GHG emissions from automobiles and trucks moving workers and materials were calculated using vehicle miles travelled estimates and appropriate emission factors from EMFAC 2007. The OFFROAD series of models are ARB's tool for estimating GHG emissions for off-road equipment, such as excavators, bulldozers, and graders. The EMFAC series of models are ARB's tool for estimating GHG emissions from on-road vehicles. In addition, rather than generic load factors, project-specific load factors were inputted into the URBEMIS 2007 program to account for updated load factor data from ARB's Nonroad 2011 database and discrepancies within URBEMIS 2007's application of load factor data.

URBEMIS 2007 was the best available model at the time. An updated analysis for CP1, and analyses for subsequent construction packages, will be calculated using GHG emission factors from ARB's OFFROAD 2011 and 2007 models[14]. The OFFROAD 2011 model provides the latest emission factors for construction off-road equipment, and accounts for lower fleet population and growth factors as a result of the economic recession and updated load factors based on feedback from engine manufacturers. The use of emission rates from the OFFROAD models reflects the recommendation of ARB to capture the latest off-road construction assumptions. OFFROAD 2011 default load factors (the ratio of average equipment horsepower utilized to maximum equipment horsepower) and information on the useful life of the equipment were used for emission estimates. Mobile source emission burdens from worker trips and truck trips will be calculated using vehicle miles travelled estimates and appropriate emission factors from EMFAC 2011.

HOW OPERATIONAL PROJECT GHG BENEFITS ARE CALCULATED

Following industry suggested best practice, the Authority calculated benefits in operation based on the results of the travel demand model, quantifying reductions in vehicle travel and plane flights, which were then converted to CO_2e using ARB GHG emissions factors.

[14] Mobile Source Emissions Inventory (EMFAC) 2011 Overview. California Air Resources Board. January 2013. Off-Road Emissions Inventory. OFFROAD 2007 (superseded) and OFFROAD 2011. California Air Resources Board. *http://www.arb.ca.gov/msei/modeling.htm/categories.htm#inuse_or_category*

VMT are the total number of vehicle miles travelled in a given geographic boundary over a specific time. For this analysis, reductions in VMT and associated GHG emissions reductions reflect vehicles in the geographic boundary. For this report, the Authority used the GHG emission factors generated using ARB's latest model, EMFAC 2011. The EMFAC series of models are ARB's tool for estimating GHG emissions from on-road vehicles. EMFAC 2011 includes the latest data on California's car and truck fleets and travel activity. The model also reflects the GHG emissions benefits of ARB's recent rulemakings including on-road diesel fleet rules, Pavley Clean Car Standards, and the Low Carbon Fuel standard.

Plane flights diverted were estimated based on the number of passengers transferring from air to high-speed rail. It was assumed for every 101 passengers diverting from air to rail, one flight would be removed[15]. Airline fuels savings, and thus GHG emissions, were estimated based on the number of flights removed. Based on a review of ARB's methodology[16] and consultation with ARB staff, the Authority calculated GHG emissions associated with the full flight cycle. That is, GHG emissions were attributed to the fuel consumed, by aircraft type, during taxi/idle, takeoff, climb, cruise, descent, landing, and taxi/idle.

To estimate GHG emissions associated with the electricity purchased by the Authority for traction power, which is the power needed to propel the train along the rails, and facilities operations, the Authority assumed a mix of 20 percent solar, 30 percent wind, 45 percent geothermal, and 5 percent biogas (methane capture)[17]. The GHG emissions factors were taken from the 2013 Climate Registry Default Emissions Factors and the Geothermal Energy Association 2012 Report, Geothermal Energy and Greenhouse Gas Emissions. This assumption regarding renewable energy reflects the Authority's commitment to 100 percent renewable energy for operations.

GHG MITIGATION ACTIVITIES

Actions that sequester greenhouse gases include forestry maintenance and increasing vegetation, particularly tree planting, and conserving some types of agricultural lands. Trees reduce atmospheric GHG levels in several ways. In particular, they directly remove carbon dioxide and assimilate it in to plant matter: branches, roots, trunks, and leaves. Other actions that reduce GHG emissions, specific to mitigation that the Authority is undertaking, include replacement of fossil fuel burning irrigation pumps with electric pumps and replacement or retrofit of vehicles with more efficient engines.

Generally, actions that sequester carbon may be GHG emissions mitigation for the purposes of calculating net GHG emissions. GHG emissions mitigation can include transportation projects, such as switching fuels or electrifying transit, forestry, and destruction or capturing of gases such as methane.[18]

The Authority is developing a multi-faceted forestry project to introduce enough trees into the region where construction is taking place to honor its commitment to offset the direct GHG emissions associated with construction. The benefits of tree planting were quantified with a model created by the U.S. Forest Service and approved for use with the ARB Compliance Offset Protocol for Urban Forest Projects[19] and the Climate Action Reserve's Urban

[15] The average plane for this corridor was assumed to have 135 seats. Industry representatives advised a 75% load factor. California High-Speed Train Final Program EIR/EIS, 2008.

[16] 2000-2009 Emissions Inventory Technical Support Document. California Air Resources Board. 2011.

[17] The Authority is still in the process of finalizing the precise mix of renewable energy for train operations. The final selection will be the result of a competitive process. For planning purposes, the analysts selected the referenced mix based on annual net capacity factors to reflect a dependable and dispatch-able generation to roughly match the high–speed rail's estimated load profile.

[18] Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit. APTA. 2009.

[19] California Air Resources Board (ARB). Compliance Offset Protocol Urban Forest Projects. 2011.

Forest Project Protocol[20]. Because GHG emissions benefits vary by region and location, the Authority's assumptions were based on conditions in California's Central Valley.

CONCLUSION

As discussed in this report, the high-speed rail program will have a positive impact on reducing the state's greenhouse gas emissions. Operations result in GHG emissions savings in the first year of operation. Savings occur in both optimistic and pessimistic ridership scenarios. The Authority is committed to construction GHG emissions being zero net through an offset program in time with construction. In addition, the Authority has exercised the influence and control it has to minimize the emissions created during construction through explicit, binding direction to the design-build contractor. Those practices and lesson learned though construction on CP1 will inform future contracts as well.

The high-speed rail project is one component of a larger statewide rail modernization and sustainable communities program. This report has calculated the project's direct contributions to the reduction of GHG emission levels. Additionally, this report highlights the cumulative benefits the state will realize from an integrated rail system linking urban centers. As the high-speed rail program advances and local communities continue to develop around it, the state's rail transportation system will play an integral role in meeting California's GHG reductions goals for 2050.

[20] Urban Forest Project Protocol. Climate Action Reserve. 2010.

REFERENCES

American Public Transportation Association (APTA). Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit. August 2009.

California Air Resources Board (ARB). California's 2000-2009: Greenhouse Gas Emissions Inventory Technical Support Document. December 2011.

California Air Resources Board (ARB). Mobile Source Emissions Inventory (EMFAC). EMFAC 2011 Overview. January 2013.

California Air Resources Board (ARB). Off-Road Emissions Inventory. OFFROAD 2007 (superseded) and OFFROAD 2011. http://www.arb.ca.gov/msei/modeling.htm/categories.htm#inuse_or_category.

California Air Resources Board (CARB). 2008a. Climate Change Scoping Plan, A Framework For Change. December 2008. Pursuant to AB 32, the California Global Warming Solutions Act of 2006.

http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

California Air Resources Board (ARB). Compliance Offset Protocol Urban Forest Projects. 2011.

California High-Speed Rail Authority (Authority). 2012 Business Plan. April 2012.

California High-Speed Rail Authority (Authority). Request for Proposals for Design-Build Services. Book 2, Part B: General Provisions. March 2012 (initial release).

California High-Speed Rail Authority (Authority). Air Quality Technical Report Merced to Fresno Section Project EIR/EIS. April 2012.

California High-Speed Rail Authority (Authority). DRAFT Fresno to Bakersfield Air Quality Technical Report. July 2012.

Climate Action Reserve (CAR). Urban Forest Project Protocol. 2010.

The Climate Registry (CR). The Climate Registry's 2013 Default Emissions Factors. January 2013.

Ehlers, Emily. HSR Report: France. SPUR. July 2010.

Geothermal Energy Association. Geothermal Energy and Greenhouse Gas Emissions. November 2012.

Kasprak, Alex. Massachusetts Department of Transportation Diesel Retrofit Program for Non-road Construction Equipment. July 29, 2011. Presentation for TRB.

National Association of Clean Air Agencies. Primer on Climate Change Science. July 2011.

Parsons Brinckerhoff. Caltrain Electrification Program Financing and Contracting Options. February 2008.

Parsons Brinckerhoff. California High-Speed Rail Benefit-Cost Analysis (BCA). April 2012.

U.S. Environmental Protection Agency (US EPA). Greenhouse Gas Equivalencies Calculator. http://www.epa.gov/cleanenergy/energy-resources/calculator.html Consulted, April 18 2013.

URBEMIS. URBEMIS Emissions Modeling Software, 2007 Version 9.2.0. Released June 2007