City of Palo Alto

City Council Staff Report

(ID # 6754)

Report Type: Action Items **Meeting Date: 4/18/2016**

Summary Title: Sustainability/Climate Action Plan and Annual Earth Day Report

Title: Review Annual Earth Day Report and Provide Direction to Staff Regarding Sustainability and Climate Action Plan (S/CAP), Including Feedback Regarding 80 Percent by 2030 Greenhouse Gas Reduction Target, Guiding Principles and Decision Criteria, Implementation Priorities, and Next Steps.

From: City Manager

Lead Department: City Manager

Recommendation

Staff recommends that the City Council receive the 2016 Earth Day Report, review the attached Draft Sustainability/Climate Action Plan (S/CAP) and provide direction to Staff regarding plan goals, guiding principles and decision criteria, implementation programs, and next steps.

Executive Summary

The attached 2016 Earth Day Report summarizes the City's sustainability related initiatives and progress since Earth Day 2015. While staff is prepared to address Council questions regarding that report, the focus of this session is on the Draft S/CAP.

The City's Office of Sustainability, working with other City staff, consulting partner DNV GL, and hundreds of community members, has researched global best practices for greenhouse gas (GHG) emission reductions and resource conservation, and evaluated the costs and benefits for a range of carbon reduction strategies. Based on that work, staff is recommending Council review the attached Draft Sustainability and Climate Action Plan (S/CAP), aimed at delivering pace-setting GHG reductions and sustainability strategies in ways that enhance quality of life, prosperity and resilience in Palo Alto.

The Draft S/CAP includes potential key elements for Council's consideration and discussion, with the understanding that the S/CAP is a long-term plan with varying time horizons for potential changes.

Background[1]

In the face of the global climate challenge:

- The International Panel on Climate Change (IPCC) has determined that "we risk severe, pervasive and irreversible impacts" from climate change, and need "substantial" greenhouse gas emissions reductions (of 40-70% or more) by mid-century.
- The international community of 192 nations, meeting at the COP21 conference in Paris in December, agreed to ***"holding the increase in the global average temperature to well below 2°C above pre-industrial levels*** *and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels...." and to commit to the* ***"highest possible ambition."***
- President Obama's March 19, 2015 Executive Order requires the federal government to cut GHG emissions by 40% by 2025 from 2008 levels.
- The State of California has committed (through Assembly Bill 32—the California Global Warming Solutions Act of 2006), to reduce its GHG emissions by 20% from 1990 levels by 2020. Executive Order S-3-05, signed in June 2005, set an aspirational goal to reduce emissions 80% by 2050. Executive Order B-30-15 (April 2015) established a California GHG reduction target of 40% below 1990 levels by 2030. SB 350 (2015) requires increasing California's renewable energy mix to 50 percent and doubling the efficiency of existing buildings by 2030.[9]
- Palo Alto has a long history of sustainability initiatives, including adoption of its first Sustainability Plan in 2002; one of the first municipal climate plans in the US in 2007; a history of exceeding energy efficiency standards in every building code cycle since 2007; and many sustainability-related policies and initiatives and provision of carbon neutral electricity in 2013, which have already reduced emissions by an estimated 35% from 1990 levels. Also in 2013, Palo Alto hired its first Chief Sustainability Officer, tasked with helping weave these many initiatives into a focused sustainability strategy.
- In 2014, Palo Alto engaged DNV GL to work with staff to develop this *Sustainability and Climate Action Plan*. After extensive research and analysis, an active community engagement process (including a five hour, 300+ participant community climate summit) and several study sessions with the UAC, CAC and Council, staff has developed the draft plan and recommendations attached here.

Discussion

At a broad level, in the course of considering and adopting this new S/CAP, Palo Alto must decide:

- What it will take to maintain its climate leadership;
- Whether to move from carbon neutral electricity to a carbon neutral utility to eventually become a carbon neutral city (which will require major changes in transportation and potentially land use as well as energy use);
- Which specific GHG emission reduction strategies and more general sustainability strategies it wishes to embrace;
- What level of investment it will make to implement those strategies;
- How quickly this could be done.

What the S/CAP is (and is not)

The S/CAP is intended as a strategic plan that proposes high-level implementation pathways, but not detailed implementation strategies and work plans; those will be developed, subject to Council guidance, by staff. The S/CAP sets strategic direction and overall goals, and suggests initial priority actions. Because of future uncertainty and changing technology, staff plans to develop more granular five-year work plans and short-term programs, rather than attempt to build a 15-year work plan.

The S/CAP presents a portfolio of plausible strategies (that have been analyzed for cost effectiveness, pace of implementation, mitigation cost, etc.) to begin to address a target goal of reducing GHG emissions to 80% below 1990 levels by 2030 (referred to as the 80x30 goal), given both technologies existing today and technology maturation trends underway. A target goal can be a useful tool to identify the efforts and assess the tradeoffs of different actions and timelines. The plan is intended to provide possible pathways that show net positive financial benefit, and an estimate of the upfront investment required to generate those benefits. The City's Office of Sustainability has identified potential sources of funds, and perhaps another follow-up work plan is to focus on the specific financing/investment pathways that could drive these net benefits to the community.

This plan is a scenario, not a prediction. While its directions are very clear—move toward deep de-carbonization through the suggested portfolio of measures—the specific rates and impacts are best estimates based on currently available information in a rapidly changing technology landscape. The S/CAP is based on assumptions—for example, about the rate of decline in electric vehicle pricing and the rate of adoption of efficiency and electrification measures—and the GHG reduction budgets presented here are sensitive to those assumptions.[2] Subject to Council interest and resourcing, staff and consultants can re-run the S/CAP model with different assumptions.

Palo Alto's trajectory

Palo Alto's sustainability and GHG reduction trajectory is summarized in Figure 1. Reducing 1990 emissions of 780,900 metric tons CO2 equivalent (MT CO2e) by 80% requires reductions equaling 624,720 tons.

Figure 1

The estimated 36% GHG reductions to date were achieved—largely over the past 10 years—through building efficiency measures and introduction of carbon neutral electricity (as well as societal trends such as more efficient appliances, not shown explicitly here).

Over the next 15 years, "business as usual" measures that are underway even if Palo Alto takes no additional steps—including both those dictated by external forces (ranging from state policy to improved federal vehicle fleet efficiency standards, as modeled by the Comprehensive Plan consultants), plus Palo Alto measures already in motion (such as existing CPAU efficiency incentive programs, Palo Alto's existing Green Building Ordinance and Reach Code, and the Bicycle and Pedestrian Plan)—will bring emissions down to an estimated 52% of 1990 levels, well ahead of California's 40% by 2030 GHG reduction goal.

Reductions to date	BAU & Existing Measures to 2030	SCAP initiatives	Total
1990-2015	2015-2030	2015-2030	1990-2030
-36%	-16%	-28%	-80%
Efficiency	**BAU reductions**	**Rethinking Mobility**	
Carbon neutral electricity	State EV adoption rates	**Efficient Electric City**	
Zero Waste programs	US fleet efficiency stds	**Zero Waste / Circular Economy**	
	Pavley Bill	**Getting Smart About Water**	
	California Building Code	**Municipal Operations**	
	Existing PA measures	**Utility of the Future**	
	Bike/Ped Master Plan	**Culture, Behavior, Innovation**	
	Zero Waste to 92% diversion	**Climate Adaptation**	
	Palo Alto Reach Code	**Regeneration & Natural Environment**	
	Some EcoPasses/GoPasses	**Financing, Funding, Investment**	
	CPAU efficiency programs		
	Etc.		

This reflects Palo Alto's longstanding commitment and initiatives already underway to drive deep carbon reductions ahead of the state or those being pursued by most other cities. Even though many of these Palo Alto measures are both aggressive and innovative, for the purpose of this report we categorize them as "business as usual"—since these staff efforts are already approved, planned or underway—provided Council maintains support for existing programs and approves these programs when they come before them.

The additional GHG reduction between those already "in-the-pipeline" reductions and the 80% reduction target for 2030 is about 224,600 MT CO2e[3], and is proposed by the S/CAP as Palo Alto's target "GHG reduction budget." The Draft S/CAP projects that 117,900 MT CO2e, or more than half of the needed additional reductions, can come from mobility related measures, 97,200 MT CO2e, or just under half from efficiency and fuel switching measures (largely in buildings), and 9,500 MT CO2e, or 4% from continuation and extension of Palo Alto's zero waste initiatives. The Draft S/CAP also proposes other sustainability measure that don't have direct or easy to determine GHG impacts but that are important for other reasons, such as water sustainability, health of the natural environment and community resilience.

S/CAP process

The S/CAP process investigated three scenarios (with different goals: 80x50, 80x30, 100x25) in considerable detail. For each, we asked: "what combination of strategies and measures might make it possible to meet that specific goal?" The list of potential measures is fairly clear, and

summarized below. (The analysis is summarized in the S/CAP Appendices.) We then filtered for technical feasibility; cost effectiveness (over time, since costs for many relevant technologies has been dropping rapidly); mitigation cost (which may make some measures attractive even if not strictly speaking cost effective, and worth exploring through alternative financing strategies). We considered likely timing, and the entry points afforded by technology life cycles. For existing buildings, we considered leverage points for change: pulling a permit, appliance failure (actual or predicted), time of sale. We assume starting with voluntary programs (like CPAU's Heat Pump Water Heater pilot), and potentially adding mandatory programs (such as the proposed Energy Reach Code proposed by Development Services) as we understand better what's possible and what's needed. And we applied informed and wherever possible documented assumptions about costs, availability, rate of adoption, etc. (Where documented data was not available—for example with new initiatives like Mobility as a Service—the assumptions are intentionally conservative, and probably underestimate GHG reduction potential.)

The S/CAP team benefited from expert opinion from Rocky Mountain Institute, as well as experts from Stanford University, Goldman Sachs, Carbon Free Palo Alto, the Urban Sustainability Directors Network, and other advisors. Community engagement included: a design charrette (40 people), an ideas expo (80 people), two polling cycles (~500 people), a community climate summit (300 people), several study sessions with Council, UAC and CAC, regular meetings with staff through the Sustainability Board and several staff retreats, the S/CAP Advisory Board (27 people), community meetings, newsletters (2500 people), social media (600 people) and individual conversations. Staff will continue to seek community input as the Draft S/CAP provides specific proposals and analysis for consideration by the City Council and the community.

Based on these efforts—research, analysis and engagement—and strong recommendations to present Council a single scenario rather than multiple scenarios, staff and consultants then focused on the target goal presented here of 80% GHG reductions by 2030. Climate neutral by 2025 was considered too speculative by many, and the California goal of 80% GHG reductions by 2030 was considered too conservative given Palo Alto's platform of accomplishments to date (though it would qualify Palo Alto to join the Climate Neutral Cities Alliance).

S/CAP measures

The Draft S/CAP's main policy recommendations are summarized here, and presented with first level implementation detail in the draft plan.

- **Mobility:**
  - ***Make it more convenient not to drive*** by developing responsive, multimodal, service-focused transportation services
  - ***Shift subsidies*** from free parking to support non-SOV travel
  - ***Support land use*** patterns that reduce both congestion and climate impacts.
  - *Support policy changes that* ***promote EV charging infrastructure*** *in public and private development and that encourage EV use by residents and commuters*

- **Efficiency & Electrification:**
  - ***Pursue large gains in energy, water and materials efficiency*** in buildings and operations,
  - *Pursue the adoption of an Energy Reach Code that **drives energy efficiency through our building codes**.*
  - Emphasize ***integrative design*** and ***streamlined policy*** approaches
  - Explore ***building stock upgrades*** toward Zero Net Energy or Net Positive through design, efficiency, renewables and bundled services packages,
  - **Encourage all-electric** new construction (if technically and legally feasible, cost-effective and directed by City Council)
  - Pursue policies that **accelerate resource efficiency upgrades of existing building stock** (residential and commercial)
  - Support a systematic ***shift from natural gas to all-electric systems***[4]***and/or renewable natural gas*** (if technically and legally feasible, cost-effective and directed by City Council)
- **Sustainable Water Management:**
  - Develop an ***integrated, long-term strategy*** that mitigates any risks of long-term shift in water supply
  - Pursue policy changes that **promote water efficiency in buildings and landscaping**
  - ***Balance*** water importation, rainwater harvesting, groundwater management, recycled water use and onsite treatment options
- **Municipal Operations:**
  - ***Embed sustainability*** in city procurement, operations and management
  - ***Set targets and track performance metrics*** *for City sustainability performance*
  - ***"Walk the talk"*** *by ensuring the City goes first on any sustainability actions requested or required of the community*
  - ***Include sustainability impacts*** in staff reports to Council, capital improvement project proposals and management reports.
- **Resilience, Adaptation and Sea Level Rise:**
  - ***Build resilience*** through risk mapping, mitigation, adaptation
  - Where necessary as a secondary response, **consider strategic retreats**.[5]
- **Regeneration and the Natural Environment / Ecosystem and Human Systems Protection:**
  - Provide a ***healthy, resilient environment*** where all species can thrive and enjoy life.
- **Utility of the Future:**
  - ***Adapt CPAU*** offerings and business model to potentially disruptive challenges facing the utility industry, including distributed generation & storage, and "grid defection"
  - ***Explore micro-grids, nano-grids*** and other resilience strategies
- **Community Behavior and Culture Change**
  - Challenge community to ***consider the impact on future generations*** of choices in lifestyle, purchases and investment.
  - Engage and support community through ***neighborhood initiatives***, interactive tools, etc.
- **Information systems:**

- o ***Advance "smart city" platforms*** for transportation, utilities, buildings, operations, finance, etc.
- o Provide ***transparent reporting and open data*** to track performance, build knowledge and fuel innovation

· **Financing Strategies:**

- o ***Finance cost-effective initiatives*** through local and external investment and new revenues, as well as general fund and enterprise fund expenditures, to the extent permitted by existing legal and regulatory framework applicable to the City.

The projected impacts of these measures are summarized in Figure 2.[6]

Figure 2

	1990	2030	Percent below the 1990 baseline	% of SCAP reduction budget
Baseline emissions	780,119			
GHG reductions achieved through 2014		278,800	36%	
State measures through 2030		80,800	7%	
Existing & pending Palo Alto initiatives		48,500	8%	
S/CAP Mobility - Expand non-auto options		34,000	4%	16%
S/CAP Mobility - Shift incentives		26,000	3%	11%
S/CAP Mobility - Balanced development		2,900	2%	1%
S/CAP Mobility - EV and ZE vehicles		55,000	6%	24%
S/CAP Energy Efficiency and electrification in Buildings		97,200	15%	33%
S/CAP Solid Waste		9,500	1%	4%
Remaining emissions (2030)		155,000	19%	

Palo Alto's ability to enact these core moves throughout the community is embedded within a regional, state and global context of regulatory and jurisdictional boundaries. In each of these areas of activity, the City has available four zones of influence:

- City government has control over its own operations, including municipal buildings, fleet, procurement and service delivery—for example, environmentally preferable purchasing.
- It can establish policies, codes, mandates, regulations and standards that drive the GHG emissions reductions of our residents and workforce—for example, our Building Code requirements for new construction and major renovations.
- It can influence community and workforce behavior through education, outreach and

voluntary programs—such as CPAU's incentive programs and Transportation Management Association (TMA) programs.

- And it can work with neighboring jurisdictions and regional authorities to develop collaborative initiatives—such as regional transportation initiatives— and to influence regional, state and national policy.

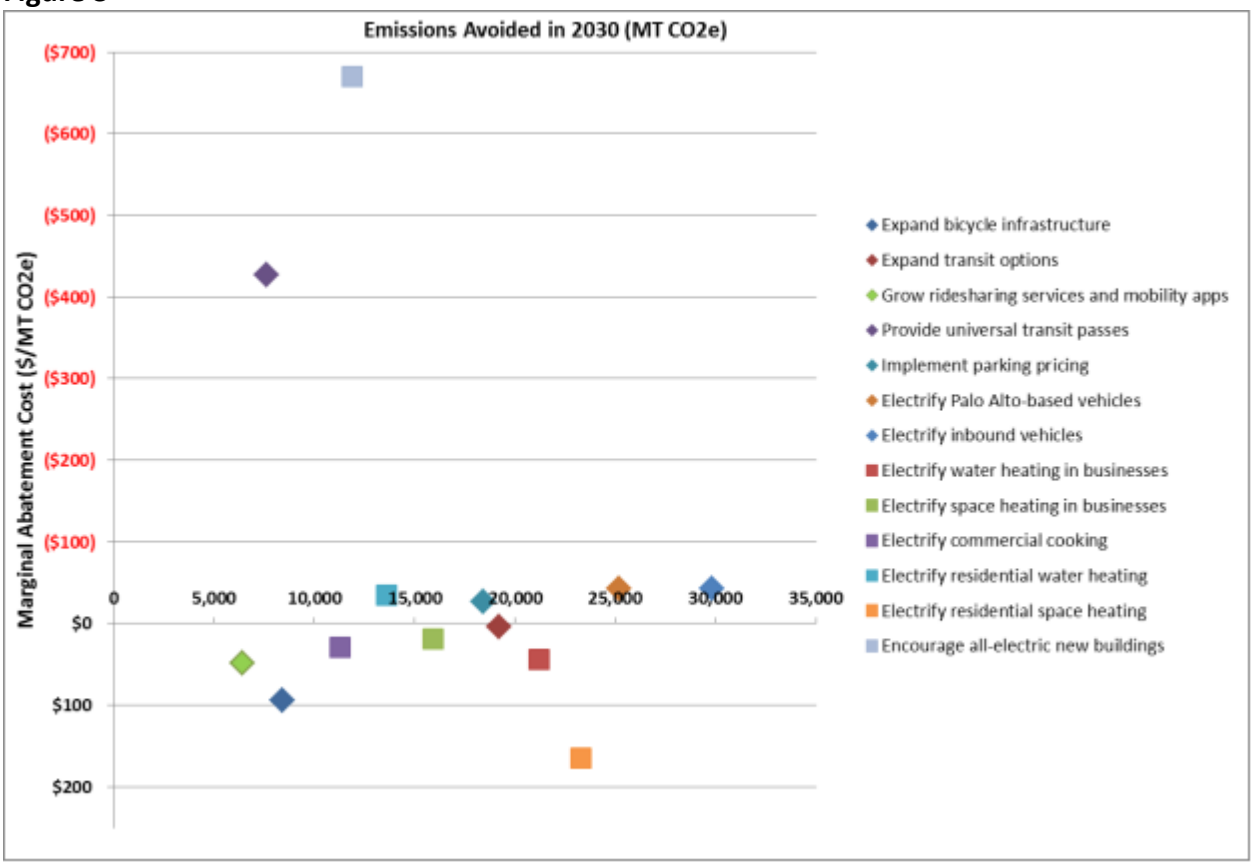
Goals and Assumptions

Key assumptions

The key assumptions underlying the projections for Mobility initiatives are shown in i the S/CAP draft and associated appendices. Some are controversial, but will hopefully provoke a grounded exploration of options and consequences. Many are ambitious, and will require rapid rates of uptake of new technologies. For example, S/CAP projects that 90% of vehicles owned in Palo Alto will be EVs by 2030. Is that possible? We don't know, given that the State projects only 30%. More useful questions might be "What measures could we undertake to accelerate that change, or to take advantage of potential market changes that move more quickly than projected (as we have seen for years with PVs, EVs and other technologies)?" and "What policies could we pursue that might eliminate barriers that would otherwise hinder the rapid expansion and proliferation of Electric Vehicles in Palo Alto?"

The relative GHG reduction impacts (in metric Tons CO2e) and associated "mitigation costs" (in $/mT) are shown in Figure 3. (The measures further to the right indicate greater impact; the measures higher on the chart indicate more favorable economics.)

Figure 3



The nature of goals, certainty & "failure"

The SCAP goals are ambitious, as called for by the Paris COP21 climate agreement. They also may be uniquely achievable by Palo Alto, because of the city's significant head start, its carbon neutral electricity platform and its control of Palo Alto Utilities. They are in any event not certain to be successfully accomplished, since they depend on many variables, both within our control—such as the desirability of CPAU services and incentives and the effectiveness of City programs—and many factors outside our control—such as the pace of price performance improvement of electric vehicles and the effectiveness of State programs.

Despite that uncertainty, stretch goals drive innovation and progress better than safe ones. Setting a big goal and perhaps not fully reaching will likely get us farther than setting a safe goal and reaching it, especially in a time of rapid change. Our key question should not be "Are we confident we can achieve it?" No one knows if ambitious climate goals are achievable, based on today's know how and experience; Johanna Partin, Director of the Carbon Neutral Cities Alliance, observes that "most of the CNCA cities…have a pretty good sense of how they're going to get to somewhere between 25-70% of their target by 2020/25/30, but no one yet knows exactly how they're going to get to 100% of their goal." We only know that we must do our best to find ways to achieve them.

Better questions might be: Is the goal worthy? Is the strategic direction right? Are the first steps right? Then let's get going, evaluate progress regularly, and revise the S/CAP as needed every

five years; let's support proposed goals with bottom up analyses, assessing, iteratively, "what combination of measures might make it possible to meet that specific goal?" As General (and later, President) Dwight D. Eisenhower observed, "Plans are useless. Planning is essential;" planning is an ongoing, iterative, adaptive process.

Staff therefore recommends that Council consider this S/CAP as a long range plan that sets a strategic framework for achieving its sustainability goals and that provides the basis for more specific action plans. As most other Climate Action Plans recognize, achieving these goals may depend on technology innovations that have not yet come online; also, it may become necessary to modify plans, specific actions or even goals as circumstances change over time. The City can commit to 2030 GHG reduction targets, and recognize that there will be multiple ways to achieve that goal; flexibility in implementation will be necessary to allow the City to evolve its strategies to achieve the most effective path to the desired result.

How to proceed

Many of the measures in the queue as well as those proposed in the S/CAP and ensuing five-year plan will require further refinement and collaboration with staff of multiple City departments. Although city staff is committed to the goal of reducing greenhouse gas emissions, there are many ways to both interpret and prioritize efforts to achieve the goal. Staff is committed to carefully assessing and prioritizing the actions and alternatives proposed, and recognizes that some priorities will need to change in order to achieve these goals. But without policy direction from the Council at the present juncture, it will be difficult for staff to determine the appropriate pace and prioritization to pursue. For this reason staff is asking for Council input on the 80 by 2030 goal and the strategic direction suggested here. Staff would be happy to provide more, specific information as desired, and to provide periodical updates to Council.

Note that the ongoing Comprehensive Plan Update is dealing with some of the same issues as the S/CAP. Discussion about how much alignment between the two plans is desirable, and what form that should take, are important questions for the Council to help answer. Council's direction and community input on the Draft S/CAP will support this process and ultimately lead to both (a) a Comprehensive Plan that sets broad community goals and policies on a wide range of subjects, supported by specific implementation programs; and (b) an S/CAP that establishes climate goals and strategies, and that addresses and supports Comprehensive Plan polices with specific implementation strategies.

Palo Alto's Sustainability and Climate Action Plan will need to be a living, learning document, providing what *Good to Great* author Jim Collins dubbed BHAGs—big, hairy, audacious goals—coupled with sensible starting points and sound initial steps.

We face great uncertainty—the pace of climate change, State and Federal policy response and technology, and public behavior change. Moving powerfully in uncertain times requires:

§ Strong directional goals

§ Clear principles & criteria
§ Flexible platforms
§ Rapid, agile prototyping
§ Timely, transparent performance tracking
§ Willingness to pivot as we learn

Recommendation
Staff recommends that the City Council discuss the attached Draft Sustainability/Climate Action Plan (S/CAP) and provide direction to Staff regarding plan goals, guiding principles and decision criteria, implementation programs, and next steps.

Resource Impact
Climate plan updates are significant undertakings for any jurisdiction. Implementation of the S/CAP will require staff resources, including potential allocation of new staff resources, and investment of public funds in both development of implementations plans and actual implementation of specific measures. Developing the S/CAP has required significant commitment of the CSO and ongoing time commitments by other staff from multiple departments, as well as the DNV consultants. Staff requirements for specific initiatives will be identified as part of work plan development, in response to initiatives approved by Council. According to S/CAP modeling estimates, City financial investment (subject to applicable legal constraints) could be significant.

Policy Implications
The Sustainability and Climate Action Plan will set forth proposed City policies and actions with regard to the topics addressed, and a framework for future discussions regarding these topics. The S/CAP Plan addresses many issues that are also addressed by the Comprehensive Plan. While staff has attempted to coordinate the two work streams as much as possible, there are inevitable differences, given the nature of each initiative, which will need to be reconciled as the planning processes advance in 2016.

The Comprehensive Plan is an update of Palo Alto's 1998 Comprehensive Plan, and has been underway since 2008; it will build on the existing plan, and incorporate goals, policies, and programs addressing climate change and climate adaption for the first time. The EIR for the Comp Plan Update will take a conservative look at potential GHG emissions through the year 2030.

While the S/CAP effort identifies the City's 2007 Climate Action Plan as its genesis, it is largely a de novo undertaking, which commenced in 2014 to present possible strategies for making Palo Alto more sustainable through 2030 and beyond. As is typical for such planning efforts, near term actions can be specific and quantifiable, while longer term actions are necessarily more aspirational and general, focusing on externally driven goals and attempting to determine whether and how best to meet them.

These two different processes will converge on some matters, and not others; however staff recognizes that the two plans must ultimately not work at cross purposes and work together as much as possible to express the community's vision for the future, and establish specific policies and strategies to guide future investments and decisions. Staff has not attempted to resolve all these differences at the staff level, since many of them are a matter of political and policy judgment, not professional judgment, and thus within the purview of Council and community, not staff.

Environmental Review

Adoption of a Climate Plan will require review pursuant to the California Environmental Quality Act (CEQA). While sustainability measures have been included in the Draft EIR that is being developed for the Comprehensive Plan Update, the final S/CAP may include additional strategies that have not been analyzed by the Draft EIR. Thus the final S/CAP will have to be reviewed to determine the appropriate level of CEQA review required.

Timeline

Review and approve S/CAP goals and framework	Q2/16
Review and approve 3-5 year Mobility implementation plan	Q2-4/16
Review approve other 3-5 year implementation plans	Q3/16
Adopt S/CAP	Q4/16

Attachments:

SCAP draft
SCAP Appendices
Earth Day Report

[1] Additional background and detail in Jan 25, 2016 Staff Report 6566, which is condensed but not repeated here.

[2] Note that in all these scenarios, reductions are partially driven by factors outside our control, including Federal and state policy, legal and regulatory constraints, cost-effectiveness of measures and technology, the pace of technology innovation, and behavioral changes by our population. In this way, the S/CAP may be similar to California Air Resources Board's (CARB's) update to the State's scoping plan, which suggests that near-term actions and targets need to be specific, quantifiable, and within an agency's control, while longer term actions and targets may require changes in technology and/or actions by others, and could be less precise. It should be noted, however, that the Draft S/CAP in some cases builds on the assumptions in the State's Scoping Plan, suggesting – for example – that the City seek to achieve a level of Electrical

Vehicle (EV) ownership (for residents and commuters) three times what the CARB is targeting state-wide for 2030.
[3] MT CO2e = metric tons of CO2 equivalent
[4] See analysis of electrification strategies, Staff Report 5971, August 2015
[5] These will be detailed in Sea Level Rise study session with Council in May.
[6] Note that all GHG emissions and reductions discussed in the S/CAP are estimates, based on best available data and assumptions. Some numbers (such as electricity, natural gas and water consumption) are based on direct measurement. Other numbers (such as landfill emissions and transportation related emissions) are derived from best available models, and are not precise measures. Staff is assuming an overall precision of +/- 10-20% on these estimates.

Attachments:

- ATTACHMENT A: S/CAP Draft (PDF)
- ATTACHMENT B: S/CAP Draft Appendices (PDF)
- ATTACHMENT C: Earth Day Report 2016 (PDF)

CITY OF
PALO ALTO

SUSTAINABILITY AND CLIMATE ACTION PLAN

Draft – April 2016

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FORWARD

We live in a time of challenge and change. The California economy, powered by the innovation engine of Silicon Valley, anchored in Palo Alto, has transformed the world. Companies like Google, Twitter, and Facebook have transformed the way we live and work. And now the world threatens to transform California. The drought—or, as some suggest, the "multi-decadal mega-drought"[1]—challenges not just our lawns, agriculture and hydroelectric power supplies, but the premise on which California civilization was built. Climate chaos may not devastate us the way that it threatens to devastate coastal regions from Bangladesh to south Florida, but heat, flooding and super storms will take their toll, and will take hundreds of billions of dollars to adapt to.

And yet… this cloud presents a silver lining. Perhaps a golden one. For in the challenge of responding to climate change, we find ourselves facing what Pogo called insurmountable opportunities, what those wild eyed radicals at Goldman Sachs see as the massive economic opportunity of a new energy economy–once again anchored here.

We are called upon to lead. Many would say the United States has lagged in response to climate challenge, compared to Europe, or China, though President Obama recent Executive Orders on emissions, energy has called the federal government to the challenge. Many would say that California has led in response to climate challenge–from revolutionizing utility regulation in the 1970s to driving the market for clean energy to our world-leading climate goals–now ratcheted up again by Governor Brown's recent Executive Orders on emissions, energy and water. Many would say that Palo Alto has been a leader in this process, with our early climate action plan, our carbon neutral electricity, and our actions to support green buildings and electric vehicles. Well, it's time for us to lead again, with a new sustainability and climate action plan that sets a new bar for leadership, that builds quality-of-life, prosperity and resilience for this community, and that sets an example once again for other communities to emulate.

We must understand and prepare for the risks ahead: climate change, with hotter and drier weather, combined with sea level rise and flooding; disruptions in resource flows and human migrations; the rise and collapse of companies and even industries; and the challenge of reinventing a way of life that was based on conditions that we may never see again.

This plan identifies a pathway to reduce our emissions 80% by 2030. Governor Brown has proposed 40% emissions reductions for California 2030. Palo Alto is already at 36%. But achieving that next 40% will not be easy, since it will require transforming transportation and dramatically reducing the climate impact of our use of natural gas for heating our buildings and water.

Because we can do this. Here.

[1] http://www.climatecentral.org/news/is-the-wests-dry-spell-really-a-megadrought-16824

INTRODUCTION

As the heart of the region that drives the eighth largest economy in the world, what is created in Palo Alto has influence far beyond its borders. Palo Alto has made impressive—and in some cases remarkable—progress toward reducing its carbon impacts, greenhouse gas emissions, and resource consumption since establishing its first Climate Protection Plan in 2007.

While cities around the world ratchet up their own sustainability initiatives, Palo Alto will need to act boldly in order to maintain its legendary leadership position—and to ensure the wellbeing of this community in the face of the challenges ahead.

In the nine years since Palo Alto created one of the first climate protection plans in United States, the world has gotten hotter, the west has gotten dryer, and more cities have stepped into the ranks of climate leadership.

Palo Alto is poised to take the next step in climate and sustainability leadership. The Sustainability and Climate Action Plan (S/CAP) is Palo Alto's ambitious plan to create a prosperous, resilient city for all residents. To support Palo Alto's leadership position on climate protection, the S/CAP provides a roadmap for how the City will continue its environmental stewardship, and exceed state requirements for GHG emission reductions.

The S/CAP is intended as a strategic plan that sets direction and overall goals, suggests initial priority actions and proposes high-level implementation pathways to achieve them.

The S/CAP presents a scenario, not a prediction. It presents a clear direction—move rapidly toward deep de-carbonization through a suggested portfolio of measures that show net positive financial benefit, and an estimate of the upfront investment required to generate those benefits. The specific measures, rates of adoption and impacts presented here are best estimates based on currently available information in a rapidly changing technology landscape; In order to be agile, adaptive and effective in the face of these changes, Palo Alto will update the S/CAP every five years, and develop more granular five-year work plans and short-term programs, rather than attempt to build a detailed 14-year work plan.

The time to act is now. In this new climate action plan, we identify a roadmap to move from carbon neutral electricity to a carbon neutral utility—and ultimately towards a carbon neutral city.

ROADMAP TO A CARBON NEUTRAL CITY

Palo Alto's Greenhouse Gas Baseline and Trends

By 2015, Palo Alto had already reduced GHG emissions an estimated 36% since 1990[2]—a remarkable achievement in 24 years, with most of it accomplished in the ten years since 2005—largely as a result of the leadership of Palo Alto Utilities and the City Council's 2013 commitment to carbon neutral electricity. Palo Alto's largest remaining sources of greenhouse gas emissions are road transportation (approximately 65%) followed by natural gas use (approximately 26%). **Figure 2** illustrates this trend, and Figure 3 provides another view of the relative size of Palo Alto's emissions sources in 2015.

The estimated 36% GHG reductions to date were achieved through building efficiency measures and introduction of carbon neutral electricity (as well as societal trends such as more efficient appliances, not shown explicitly here). Over the next 15 years, a variety of external trends (designated in this Plan as "business as usual 1" or BAU1), including Federal and state policy (such as building efficiency and vehicle efficiency standards) and demographic changes, are expected to reduce Palo Alto emissions to an estimated 45% below 1990 emissions by 2030[3]—in line with the State of California's interim 2030 reduction target of 40%. Initiatives that the City has already approved or set in motion (such as existing CPAU efficiency incentive programs, Palo Alto's existing Green Building Ordinance and Reach Code, and the Bicycle and Pedestrian Plan), will bring emissions down to an estimated 52% of 1990 levels—provided Council maintains support for existing programs and approves these programs when they come before them. This reflects Palo Alto's longstanding commitment and initiatives already underway to drive deep carbon reductions ahead of the state or those being pursued by most other cities. Even though these Palo Alto plans are both aggressive and innovative, for the purpose of this report we categorize them as "business as usual "—since these efforts are already in the queue.

The additional GHG reduction between those already "in-the-pipeline" reductions and the 80% reduction target for 2030 is about 224,600 MT CO2e[4], and is proposed by the S/CAP as Palo Alto's target "GHG reduction budget." The Draft S/CAP projects that 117,900 MT CO2e, or more than half of the needed additional reductions, can come from mobility related measures, 97,200 MT CO2e, or just under half from efficiency and fuel switching measures (largely in buildings), and 9,500 MT CO2e, or 4% from continuation and extension of Palo Alto's zero waste initiatives. The Draft S/CAP also proposes other sustainability measure that don't have direct or easy to determine GHG impacts but that are important for other reasons, such as water sustainability, health of the natural environment and community resilience.

[2] Palo Alto emissions in the 1990 baseline year are estimated at 780,119 MTCO2e, a restatement of prior estimates based on revised analyses using updated emissions models. Most emissions noted in this report as called "estimates," since only utility consumption (electricity, natural gas and water) are measured. Transportation emissions are modeled every few years; solid waste related emissions are calculated using established EPA protocols. Solid waste related emissions were not included in the CompPlan DEIR.

[3] Based on the "business as usual" analysis conducted for the CompPlan DEIR.

[4] MT CO2e = metric tons of CO2 equivalent

Figure 1. Palo Alto Community-wide GHG Emissions (MT CO2e)

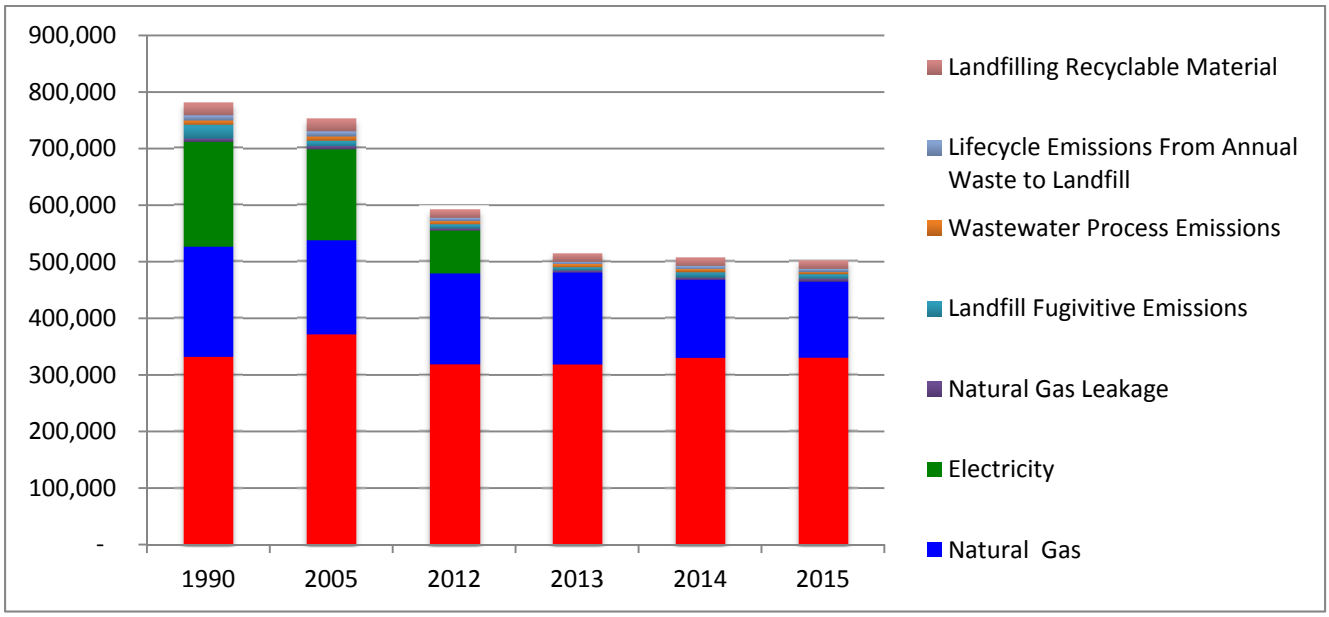
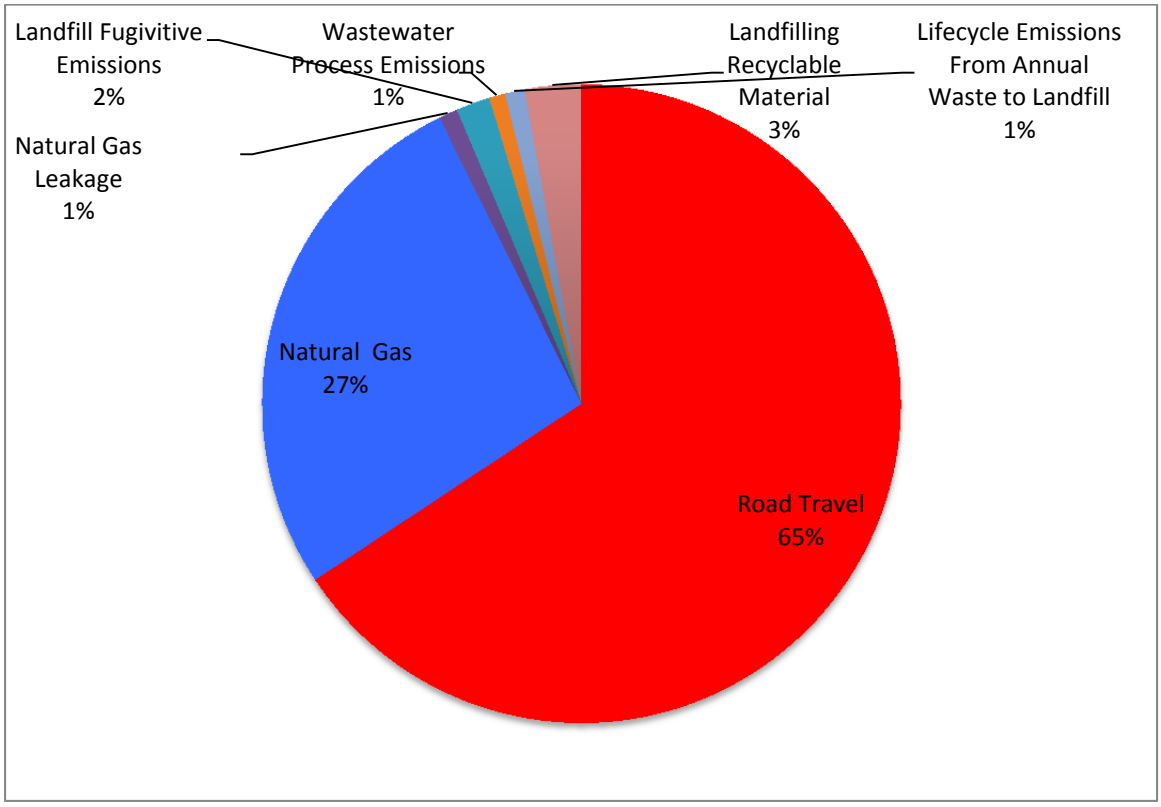
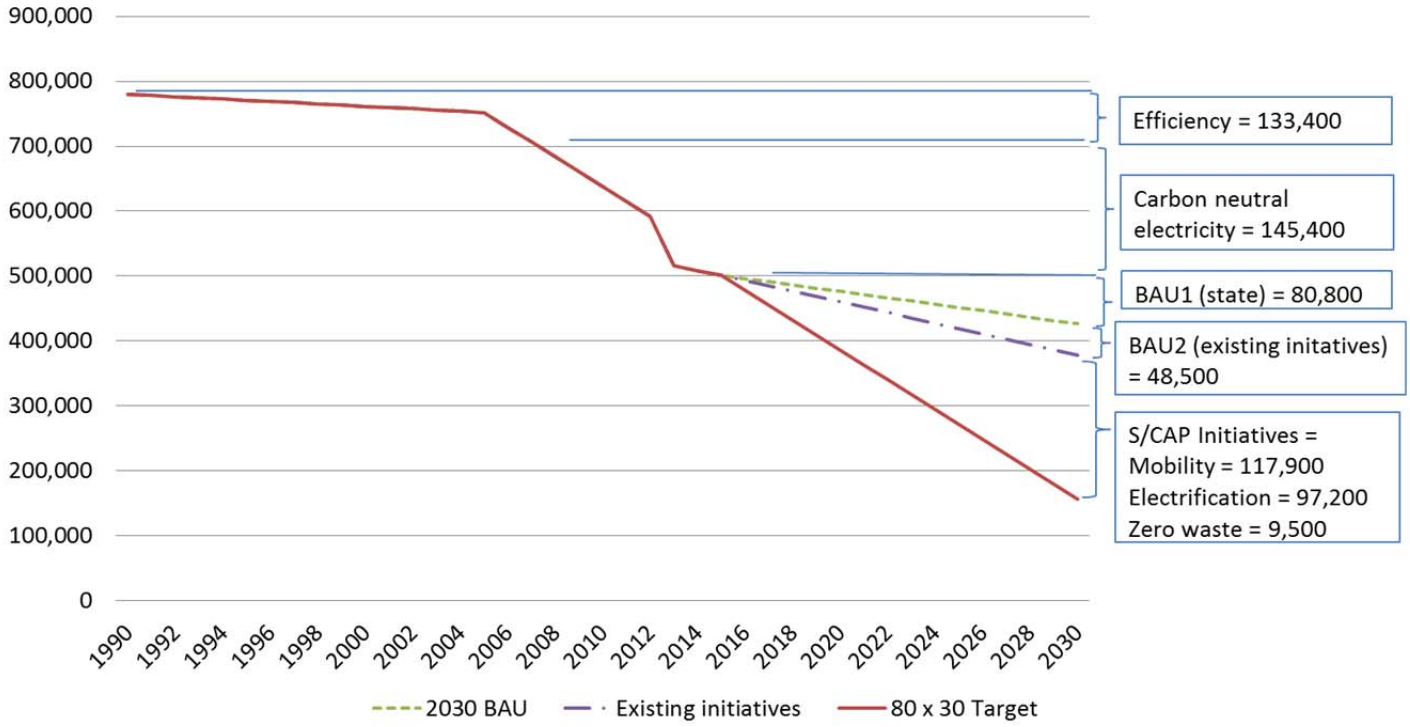


Figure 2. Palo Alto 2015 Community-wide GHG Emissions Sectors



A detailed emissions analysis can be found in Appendix X.

Figure 3. Overview of Palo Alto GHG Reduction Target relative to Business-as-Usual (MT CO2e)

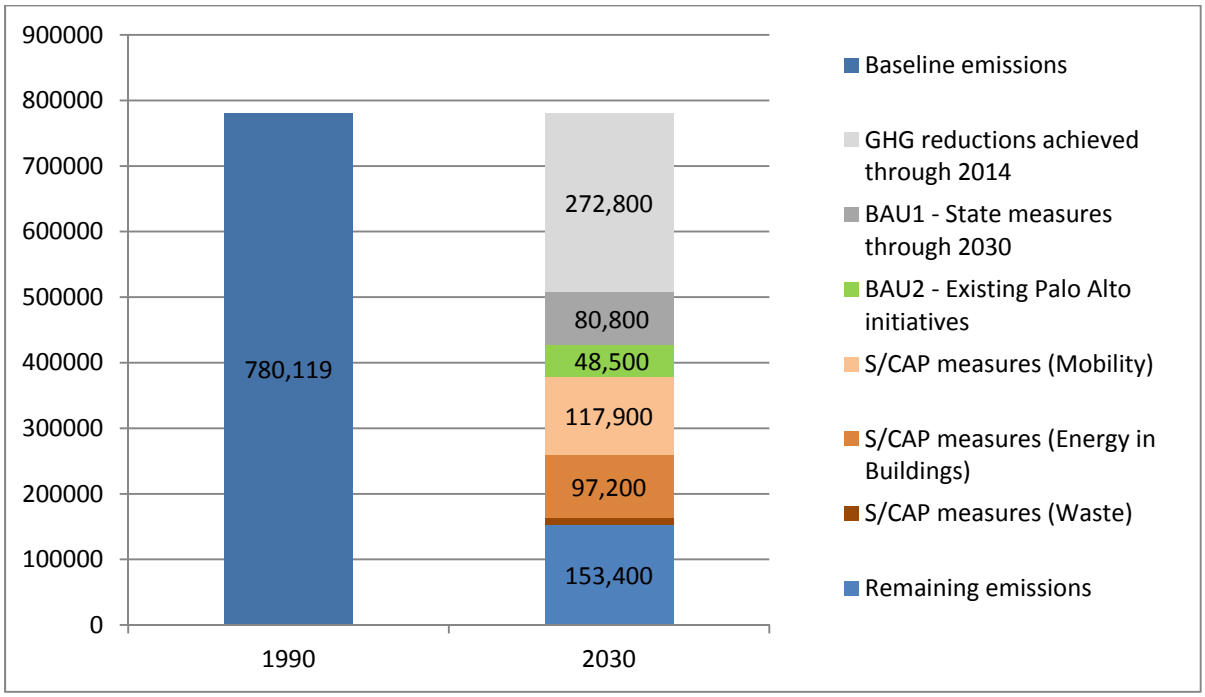


A Roadmap for "80 x 30"?

Palo Alto has substantially exceeded the 20% reduction goals set by Council in 2007 Climate Protection Plan, and is positioned to establish new goals for Palo Alto to continue its global leadership, commit to a low- or zero-carbon future, and create a roadmap to that future.

This plan focuses on pathways to a low-carbon future, and initiatives addressing water, green infrastructure, adaptation and regeneration as part of a holistic framework for sustainability. Specifically, it explores a possible pathway for reducing Palo Alto's GHG emissions by 2030 from the current level of 36% below 1990 levels to 80% below 1990 levels by 2030 ("80x30"), 20 years ahead of the State of California 80x50 target. This represents a GHG reduction "budget" of 260,000 tons (as shown in Figure 5 and detailed below), and will be possible only if Palo Alto continues its longstanding commitment to sustainability and if a number of assumptions that are outside the City's control come to fruition.

Figure 4: 80x30 GHG Reduction Budget (MT CO2e)



Reducing greenhouse gas emissions in order to avoid potentially catastrophic climate change is a key driver for the S/CAP, but it is not the only indicator for sustainability. Therefore, the S/CAP is organized around ten overarching levers for sustainability, including some without direct quantifiable impacts on greenhouse gas emissions, but which are central to a holistic approach for sustainability in Palo Alto that protects and enhances our natural resources for generations to come. These are summarized in Figure 5, below, and described in more detail in the sections that follow.

Key Levers for Sustainability and Climate Action

S/CAP's main recommendation measures are summarized here, and presented with first level implementation detail in the draft plan.

- **Mobility:**
  - ***Make it more convenient not to drive*** by developing responsive, multimodal, service-focused transportation services
  - ***Shift subsidies*** from free parking to support non-SOV travel

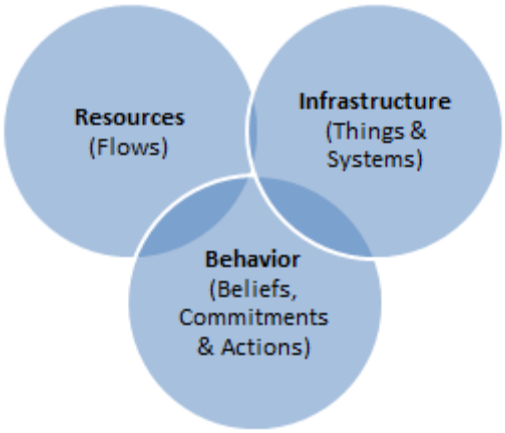
    - ***Shift land use*** patterns reduce both congestion and climate impacts.
    - *Support policy changes that **promote EV charging infrastructure** in public and private development and that encourage EV use by residents and commuters*
- **Efficiency & Electrification:**
    - ***Pursue large gains in energy, water and materials efficiency*** in buildings and operations,
    - *Pursue the adoption of an Energy Reach Code that **drives energy efficiency through our building codes**.*
    - Emphasize ***integrative design*** and ***streamlined policy*** approaches
    - Explore ***building stock upgrades*** to Zero Net Energy or Net Positive through design, efficiency, renewables and bundled services packages,
    - **Encourage all-electric** new construction (if technically and legally feasible, cost effective and directed by City Council)
    - Rapidly upgrade the resource efficiency of existing building stock (residential and commercial)
    - Support a systematic ***shift from natural gas to all-electric systems[5] and/or renewable natural gas*** (if technically and legally feasible, cost-effective and directed by City Council)
- **Sustainable Water Management:**
    - Develop an ***integrated, long-term strategy*** that mitigates risks of long-term shift in water supply
    - Pursue policy changes that **promote water efficiency in buildings and landscaping**
    - ***Balance*** water importation, rainwater harvesting, groundwater management, recycled water use and onsite treatment options
- **Resilience, Adaptation and Sea Level Rise:**
    - ***Build resilience*** through risk mapping, mitigation, adaptation
    - Where necessary as a secondary response, consider strategic retreats.
- **Municipal Operations:**
    - ***Embed sustainability*** in city procurement, operations and management
    - ***Set targets and track performance metrics*** *for City sustainability performance*
    - ***"Walk the talk"*** *by ensuring the City goes first on any sustainability actions requested or required of the community*
    - ***Include sustainability impacts*** in staff reports, capital improvement project proposals and management reports.
- **Regeneration and the Natural Environment / Ecosystem and Human Systems Protection:**
    - Provide a ***healthy, resilient environment*** where all species can thrive and enjoy life.
- **Utility of the Future:**
    - ***Adapt CPAU*** offerings and business model to potentially disruptive challenges facing the utility industry, including distributed generation & storage, and "grid defection"
    - ***Explore micro-grids, nano-grids*** and other resilience strategies
- **Community Behavior and Culture Change**
    - Challenge community to ***consider the impact on future generations*** of choices in lifestyle, purchases and investment.
    - Engage and support community through ***neighborhood initiatives***, interactive tools, etc.
- **Information systems:**
    - ***Advance "smart city" platforms*** for transportation, utilities, buildings, operations, finance, etc.
    - Provide ***transparent reporting and open data*** to track performance, build knowledge and fuel innovation
- **Financing Strategies:**
    - ***Finance cost-effective initiative*** through multi-channel, non-general fund, local and external investment in support of these goals, to the extent permitted by existing legal and regulatory framework applicable to the City.

[5] See analysis of electrification strategies, Staff Report 5971, August 2015

These measures will require strategies that address three domains of action (shown in **Figure 5**), all of which are critical to realizing the sustainability vision:

- institutions that form the structure of policies and programs,
- behavioral change to modify mindsets and personal actions, and
- financial considerations that drive markets.

Figure 5. S/CAP Three Domains of Action



A few core moves

Palo Alto's sustainability strategies ultimately rely on a few "core moves" for reducing impact on the environment and GHG emissions, and doing so in ways that improve the quality of life of our community:

- Reducing resource use, for example through energy efficiency measures;
- Shifting resource use impacts, for example by electrification;
- Transforming systems, for example by outcompeting single occupancy driving with mobility services.

REDUCE

- Energy efficiency
- Water conservation
- Walking/biking instead of driving
- Zero waste

SHIFT

- Convert to electric vehicles
- Electrify water and space heating
- Greywater or rainwater instead of potable water

TRANSFORM

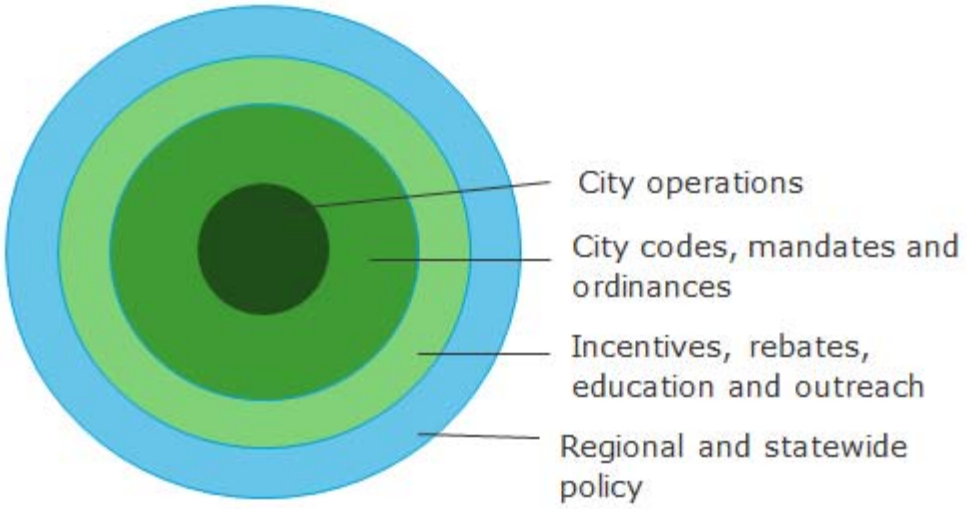
- Mobility as a Service instead of individual car ownership
- Transit-oriented development
- Utility of the Future

Zones of Control and Influence

Palo Alto's ability to enact these core moves throughout the community is embedded within a regional, state and global context of regulatory and jurisdictional boundaries. **Figure 6** illustrates Palo Alto's levels of control and influence.

- City government has control over its own operations, including municipal buildings, fleet, procurement and service delivery—for example, environmentally preferable purchasing.
- It can establish policies, codes, mandates, regulations and standards that drive the GHG emissions reductions of our residents and workforce—for example, our PV readiness requirements for new construction and major renovations.
- It can influence community behavior through education, outreach and voluntary programs—such as CPAU's incentive programs.
- And it can work with neighboring jurisdictions and regional authorities to develop collaborative initiatives—such as regional transportation initiatives— and to influence regional, state and national policy.

Figure 6. Palo Alto Jurisdictional Influence and Control



Levers, Goals, Strategies and Actions

Figure 7 presents the key components of Palo Alto's path to further GHG reductions:

- The primary levers with which we can shift emission trends
- The goals we will establish to activate those levers
- The strategies and actions by which we will achieve those goals

Figure 8 summarizes the emissions reduction potential of the proposed strategies, and the key players responsible for implementation, and **Figure 9** shows this summary by goal. For several strategies, Palo Alto will need to work with regional and state entities to advocate for policies and programs to support Palo Alto efforts and initiatives. The levers, goals, strategies and actions are based on Palo Alto's baseline emissions sources, existing and planned initiatives and a literature review of best practices for city climate action planning for effective new GHG reduction opportunities. (Note: Not all the strategies and actions in this Plan are summarized here, since some don't have direct GHG reduction impacts, or those impacts are impossible to estimate at this time.)

Figure 7. Overview of 3 Key Levers, Goals and Strategies for GHG Reductions

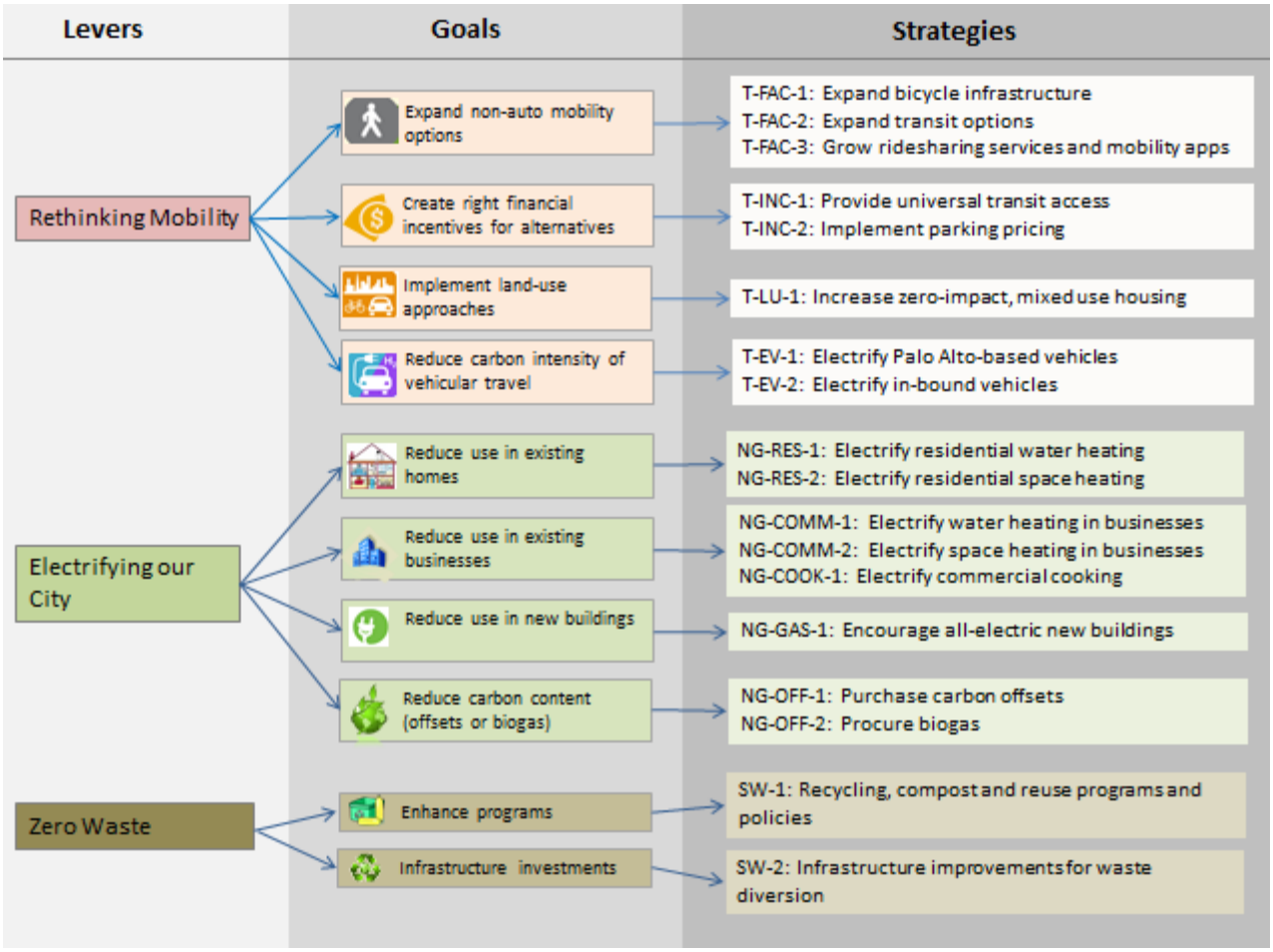
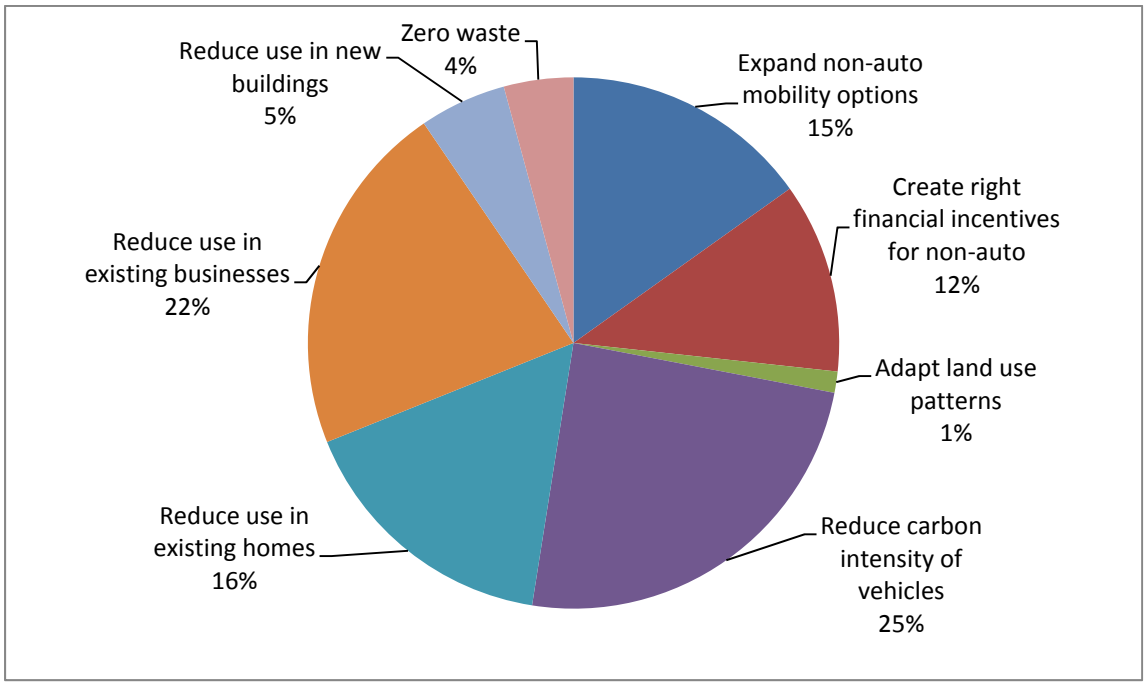


Figure 8. S/CAP Strategies to Achieve 80 x 30 Goal

Levers	Goals	Strategy	Jurisdiction PA = Palo Alto R = Regional S = State	GHG Avoided in 2030 (MT CO2e)	Percent of Total S/CAP Emissions Reductions	Percent of Reductions from 1990 Baseline
Rethinking Mobility	Expand non-auto mobility options	T-FAC-1. Expand bicycle infrastructure	PA	8,400	4%	1%
		T-FAC-2. Expand transit options	PA, R	19,200	9%	2%
		T-FAC-3. Grow ridesharing services and mobility apps	PA	6,400	3%	1%
	Create right financial incentives	T-INC-1. Provide universal transit passes	PA	7,600	3%	1%
		T-INC-2. Implement parking pricing and feebates	PA	18,400	8%	2%
	Adapt land use patterns	T-LU-1. Increase zero-impact, mixed use housing	PA	2,900	1%	2%
	Reduce carbon intensity of vehicles	T-EV-1. Electrify Palo Alto-based vehicles	PA	25,200	11%	3%
		T-EV-2. Electrify inbound vehicles	PA, R	29,800	13%	3%
Electrifying our City	Reduce use in existing businesses	NG-COMM-1. Electrify water heating in businesses	PA, S	21,200	9%	5%
		NG-COMM-2. Electrify space heating in businesses	PA, S	15,900	7%	3%
		NG-COOK-1. Electrify commercial cooking	PA, S	11,300	5%	2%
	Reduce use in existing homes	NG-RES-1. Electrify residential water heating	PA, S	13,600	6%	2%
		NG-RES-2. Electrify residential space heating	PA, S	23,300	10%	3%
	Reduce use in new buildings	NG-GAS-1. Encourage all-electric new buildings	PA, S	11,900	5%	2%
Zero Waste	Enhance programs and infrastructure	SW-1. Achieve zero waste	PA	9,500	4%	1%
			TOTAL	224,600	100%	33%

Figure 9. Summary of S/CAP Emissions Reductions by Goal



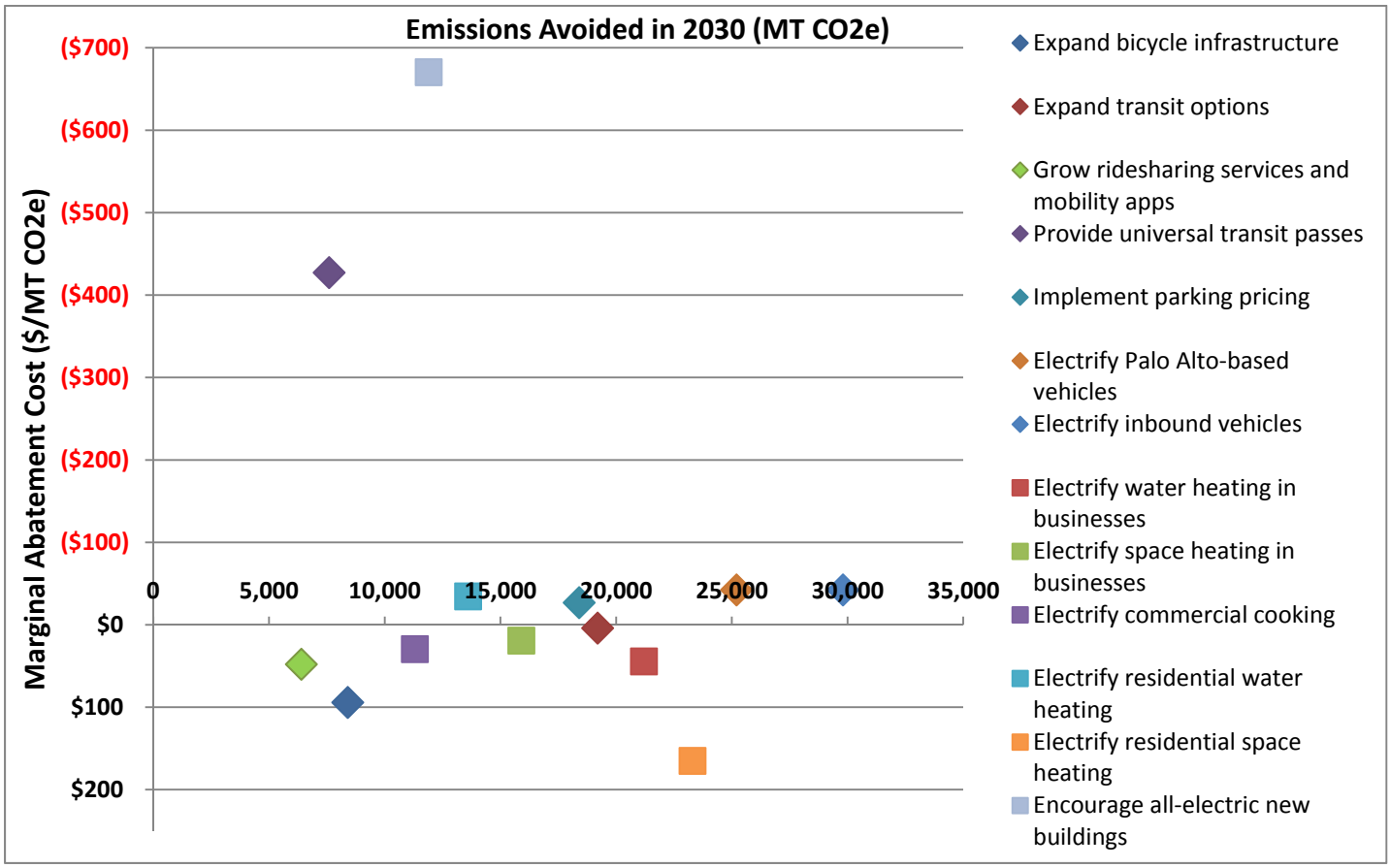
Key assumptions

The key assumptions underlying the projections for the impacts of these initiatives are shown in Table XX. Some are controversial, but will hopefully provoke a grounded exploration of options and consequences.[6] Many are ambitious, and will require rapid rates of uptake of new technologies. For example, S/CAP projects that 90% of vehicles owned in Palo Alto will be EVs by 2030. Is that possible? We don't know, given that the State projects only 30%. More useful questions might be "What measures could we undertake to accelerate that change, or to take advantage of potential market changes that move more quickly than projected (as we have seen for years with PVs, EVs and other technologies)?" and "What policies could we pursue that might eliminate barriers that would otherwise hinder the rapid expansion and proliferation of Electric Vehicles in Palo Alto?"

The relative GHG reduction impacts (in metric Tons CO2e) and associated "mitigation costs" (in $/mT) are shown in Figure 1. (The measures further to the right indicate greater impact; the measures higher on the chart indicate more favorable economics.)

[6] Note that in all these scenarios, reductions are partially driven by factors outside our control, including Federal and state policy, legal and regulatory constraints, cost-effectiveness of measures and technology, the pace of technology innovation, and behavioral changes by our population. In this way, the S/CAP may be similar to California Air Resources Board's (CARB's) update to the State's scoping plan, which suggests that near-term actions and targets need to be specific, quantifiable, and within an agency's control, while longer term actions and targets may require changes in technology and/or actions by others, and could be less precise. It should be noted, however, that the Draft S/CAP in some cases builds on the assumptions in the State's Scoping Plan, suggesting – for example – that the City seek to achieve a level of Electrical Vehicle (EV) ownership (for residents and commuters) three times what the CARB is targeting state-wide for 2030.

Figure 10. Prioritizing Actions by GHG Impact & Mitigation Cost



The Power of "Unreasonable" Goals

The SCAP goals are ambitious, as called for by the Paris climate agreement. They also may be uniquely achievable by Palo Alto, because of the city's significant head start, its carbon neutral electricity platform and its control of Palo Alto Utilities. They are in any event not certain to be successfully accomplished, since they depend on many variables, both within our control—such as the desirability of CPAU services and incentives and the effectiveness of City programs—and many factors outside our control—such as the pace of price/performance improvement of electric vehicles and the effectiveness of State climate programs.

Despite that uncertainty, stretch goals drive innovation better than safe ones. Setting a big goal and perhaps not fully reaching will likely get us farther than setting a safe goal and reaching it, especially in a time of rapid change. Our key question should not be "Are we confident we can achieve it?" No one knows if ambitious climate goals are achievable, based on today's knowhow and experience; Johanna Partin, Director of the Carbon Neutral Cities Alliance, observes that "most of the CNCA cities…have a pretty good sense of how they're going to get to somewhere between 25-70% of their target by 2020/25/30, but no one yet knows exactly how they're going to get to 100% of their goal." We only know that we must do our best to find ways to achieve them.

Better questions might be: Is the goal worthy? Is the strategic direction right? Are the first steps right? If so, then let's get going, and re-evaluate goals and progress in five years; let's support proposed goals with bottom up analyses, assessing "what combination of measures might make it possible to meet that specific goal?" As General (and later, President) Dwight D. Eisenhower observed, "Plans are useless. Planning is essential."

Guiding Principles

The Vision Statement for the 1998 Comprehensive Plan Governance Element declares that:

> "Palo Alto will maintain a positive civic image and be a leader in the regional, state, and national policy discussions affecting the community. The City will work with neighboring communities to address common concerns and pursue common interests. The public will be actively and effectively involved in City affairs, both at the Citywide and neighborhood levels."[7]

S/CAP builds on that vision with these guiding principles as a basis for effective and sustainable decision-making:

- Consider "sustainability" in its broadest dimensions, including quality of life, the natural environment and resilience, not just climate change and greenhouse gas emissions reductions.
- Address the sustainability issues most important to the community and select most cost-effective programs and policies—recognizing that this will entail moral and political, as well as economic, decision factors.
- Seek to improve quality of life as well as environmental quality, economic health and social equity.
- Foster a prosperous, robust and inclusive economy.
- Build resilience—both physical and cultural—throughout the community.
- Include diverse perspectives from all community stakeholders, residents, and businesses.
- Recognize Palo Alto's role as a leader and linkages with regional, national and global community.

Design Principles

In both evaluating this S/CAP, and in developing and evaluating future programs guided by it, Palo Alto is guided by these design principles:

- Focus on what's feasible—recognizing that technology and costs are shifting rapidly.
- Prioritize actions that are in the City's control – recognizing that we can urge others to join us, but leading by example is most effective
- Be specific about the actions and costs to achieve near-term goals, while accepting that longer-term goals can be more aspirational
- Use ambient resources: Maximize the efficient capture and use of the energy and water that fall on Palo Alto.
- Full cost accounting: Use total (life cycle) cost of ownership and consideration of externalities to guide financial decisions, while focusing on emission reductions that achievable at a point in time (i.e. not on life cycle emissions).
- Align incentives: Ensure that subsidies, if any, and other investment of public resources encourage what we want and discourage what we don't want.
- Flexible platforms: Take practical near term steps that expand rather than restrict capacity for future actions and pivots.

Decision Criteria

In selecting specific programs and policies to pursue, and in allocating public resources to support them, Palo Alto will be guided by these decision criteria:

- Greenhouse gas impact
- Quality of life impact

[7] http://www.paloaltocompplan.org/plan-contents/governance-element/

- Mitigation cost
- Return on investment (ROI)
- Ecosystem health
- Resilience
- Impact on future generations

Overarching Policies and Legal Issues

The proposals set forth in the draft S/CAP will need to be specifically analyzed in the context of applicable local, state and federal legal requirements, policy tradeoffs, budget and cost considerations, technological feasibility and economic impacts to the City prior to any adoption. Implementation of any of the new policies and programs described in the draft S/CAP will also be subject to the same considerations, as determined periodically by the Palo Alto City Council, and will continue to take into account existing local, state, and federal laws, regulations, and programs to avoid unnecessary duplication, minimize uncertainty, and maximize predictability.

Measures presented here constitute a preliminary menu of options for Council to consider as potential methods for achieving greenhouse gas reduction goals adopted by Council; the proposals set forth in the draft S/CAP are for discussion and the City of Palo Alto.

RETHINKING MOBILITY

Road transportation represents about 61% of Palo Alto's carbon footprint—and a congestion headache for everyone. Palo Alto's existing Comprehensive Plan calls for reducing reliance on the automobile, and we've made some progress, with reductions in commute trips by Single Occupant Vehicles (SOV) from 75% to 62% between 2000 and 2014 and to 55% for commuters to Downtown. We've also dramatically reduced car trips to Palo Alto schools, with 44% of high school students commuting by bicycle. Beyond our borders, federal CAFE standards have reduced the carbon intensity of the US vehicle fleet. But congestion continues unabated, and the majority of Palo Altans, and commuters to Palo Alto still make Single Occupancy Vehicle (SOV) trips in fossil fuel powered vehicles.

GHGs from road travel are a function of two factors: Vehicle Miles Travelled (VMT), and the carbon intensity of that travel (GHG/VMT). Reducing GHG/VMT is largely a function of vehicle technology, driven for example by Federal CAFE standards, state policy, improved fuel efficiency, electrification and customer adoption. Most of these factors are outside the purview of cities, but Palo Alto has some ways to influence VMT, by developing attractive alternatives to SOV trips, and GHG/VMT, largely by encouraging electrification of City, resident and commuter fleets.

Traditional approaches to transportation—adding capacity by building roads and parking—send the wrong signals, encourage SOV travel and add pain. But what if we asked a different question: **How could we make it more convenient for anyone, anywhere, anytime to not have to get into a car and drive?**

The key tools the City has for doing so include:

- Optimizing transit
- Electrifying Vehicles
- Incentivizing People to change their travel modes
- Integrating Transportation Network Companies (TNCs) and Autonomous Vehicles
- Implementing land use policies that support these shifts.

Goal: Expand non-auto mobility options

This goal focuses on improving alternative modes of transportation to support non-automobile based mobility. The key: making it more convenient for anyone, anywhere, at any time, not *have* to drive by

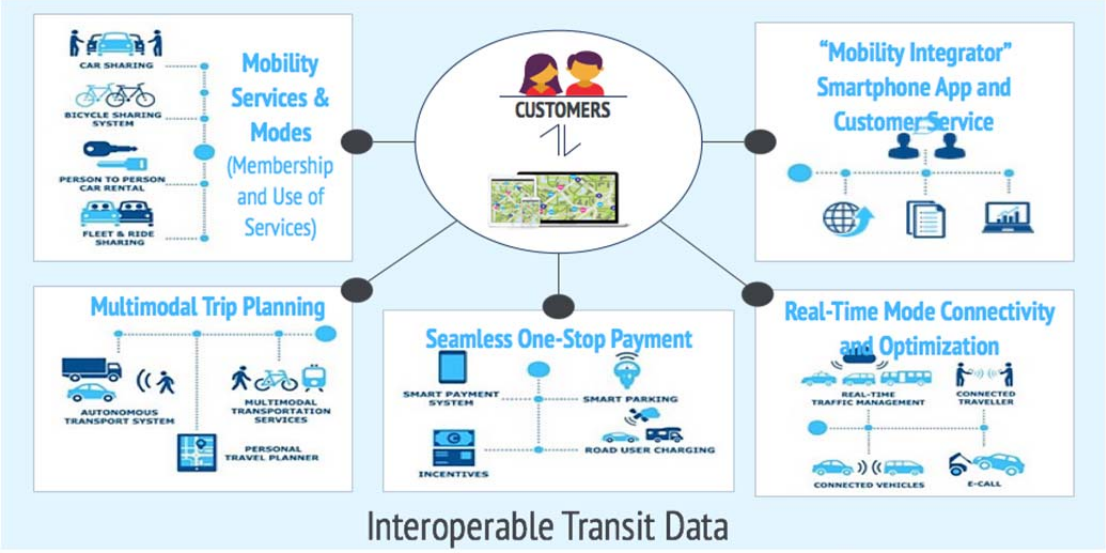
- Expanding existing initiatives (such as bike infrastructure)
- Targeting specific populations with relevant non-SOV services that they can afford
- Developing advanced, software-based solutions (MaaS)
- Continually tracking performance of these programs overtime

"Mobility as a Service" (MaaS) is an integrative approach that proposes to shift the traditional focus from fixed transportation to flexible, responsive transportation services designed to meet people's diverse and changing needs by providing seamless regional multi-modal mobility services, including improved transit, and bike share; dynamic, on-demand shuttles; flexible first &

TDM/TMA: The City supports a number of emerging transportation demand management (TDM) initiatives including its first Transportation Management Association (TMA)[1], which will develop, manage, and market transportation programs to reduce single occupancy vehicle trips in the Downtown Core area. The Comprehensive Plan Update also provides an opportunity to establish policies that outline when TDM should be applied and programs that specify how compliance will be periodically measured and enforced. TDM plans for individual development projects can establish TDM requirements and set enforceable SOV mode-share targets. TDM plans would establish a list of acceptable TDM measures that include transit use, prepaid transit passes, commuter checks, car sharing, carpooling, parking cash-out, bicycling, walking, and education and outreach to support the use of these modes. They should provide a system for incorporating alternative measures as new ideas for TDM are developed.

last mile solutions; walkable/bikeable communities; and smart apps that provide convenient access to all of these.

Figure 11. Mobility as a Service (MaaS) Schematic



Source: Finland Ministry of Transport and Communications & Rocky Mountain Institute

Strategy	2030 Target	2030 GHG Emissions Reduction
T-FAC-1. Expand bicycle infrastructure	Increase bike boulevard miles to 26 miles Increase bike mode share, including work commute trips, from 7% to 25%	8,400 MTCO2e
T-FAC-2. Expand transit options	Increase transit ridership by 60%	19,200 MTCO2e
T-FAC-3. Grow ridesharing services and mobility apps	Increase in rideshare mode	6,400 MTCO2e

Strategy: Expand bicycle infrastructure (T-FAC-1)

Upgrade and integrate bicycle network (T-FAC-1.1)

- Continue to integrate bicycle boulevards with separated bikeways on arterial street and off-street paths and trails to create an integrated network of internal and inter-city routes that are safe and comfortable for use by cyclists of all ages and abilities, and accessible to all major destinations in the City.
- Ensure bikeway networks are represented on online mapping
- Install bicycle and pedestrian sensors on utility poles to track transportation mode shares
- Convert 40% of bike lanes to protected bike lanes by 2030.
- Evaluate what would be required to achieve bicycle mode share levels being targeted by other cities, ranging from Portland and Copenhagen and LA.
- Develop bike routes that link effectively with adjacent jurisdictions.
- Reduce gaps in bikeways by creating a stress map to identify gaps
- Institute additional car-free streets through extending days that University Avenue is car-free
- Replace parking lanes in specific areas with separated bike lanes

Increase bike boulevard mileage within Palo Alto (T-FAC-1.2)

- Implement 2012 Bicycle and Pedestrian Transportation Plan proposals for new additions to the bicycle boulevard network, and a design toolbox that emphasizes integrated wayfinding, speed limit reductions, actuated arterial crossings, and greater use of traffic circles as a replacement for stop signs.
- Increase bicycle boulevards network to increase bicycle mode share, safety, and mobility.

Reestablish and expand Palo Alto bike share program (T-FAC-1.3)

- Work with neighboring cities to establish a program to continue a bike share program, and expand the number of bikes from the 37 bikes at five stations to more than 20 stations by 2020.
- Update the City's Bicycle and Pedestrian Transportation Plan every 5 years.
- Integrate bike share into regional transit payment media, commuter wallet and Clipper 2.0
- Incentivize e-bikes through rebates
- Incentivize e-bikes through charging infrastructure in bike racks

Strategy: Expand transit options (T-FAC-2)

Expand ridership on SamTrans, VTA, Dumbarton Express and Palo Alto shuttles. (T-FAC-2.1)

- Complete shuttle study to determine what is needed to increase ridership
- Increase marketing, information, and education about transit service and how to use different transit options
- Decrease shuttle headways to 10 minutes or less during commute hours and 15 minutes or less at other times.
- Contract low-carbon or zero-carbon shuttle fleet
- Add transit service to high demand routes and upgrade service on other routes to expand the network of routes achieving frequent service standards.
- Institute queue jump lanes for high ridership and regional transit lines (e.g., Dumbarton Express, 522 ECR, high ridership shuttles)
- Support and enhance inclusion of public and private school commute patterns in the local transit system, including schedule and route coordination.
- Provide real time, "next bus" scheduling information at shelter stops, on smart phones and integrate into "commuter wallet" as part of MaaS.

- Provide (or invite) dynamically responsive shuttles.

Achieve target levels of ridership of Caltrain Modernization. (T-FAC-2.2)

- Provide real-time arrival information at shelters, stops and on phones, integrated into the "commuter wallet"
- Ensure inter-operable, real time data across all transit agencies, and support efforts to integrate train, bus, and shuttle schedules
- Continue to encourage the provision of amenities such as seating, lighting, and signage including real-time arrival information, at bus and shuttle stops and train stations to increase rider comfort, safety, and convenience.
- Support continued development and improvement of the Caltrain Stations as important transportation nodes for the City.
- Develop and improve Caltrain stations as transit hubs with amenities such as bike share, showers, bike parking, car share, and designated areas for transportation network companies
- Improve access to Caltrain stations, including better connections to Stanford Research Park through new shuttles
- Focus new development near Caltrain stations, particularly within ¼ mile.
- Work with Peninsula Corridor partners to upgrade the Caltrain corridor to provide reliable, frequent, all day high capacity transit service to/from destinations along the US101 corridor from San Francisco to San Jose (and on to Gilroy).
- Decrease wait times for intercity transit to 10 minutes or less during commute hours and 15 minutes or less at other times.
- Ultimately, support development, as needed, of additional tracks and stations, and potentially grade separation of all or a part of the Caltrain corridor.

Strategy: Grow ridesharing services and mobility apps (T-FAC-3)

Increase shared transportation ridership rates (T-FAC-3.1)

- Facilitate casual carpool, and use of Transportation Network Companies (TNCs; eg, Uber, Lyft, and others) for dynamic commute ridesharing and for first mile/last-mile travel options.
- Provide financial assistance and driver opportunities to low-income TNC riders

Support infrastructure for ridesharing (T-FAC-3.2)

- Adopt carpool matching app/service with City employees serving as initial pilot
- Designate curb space for rideshare/carpool pick-up and drop-off downtown, and at Caltrain Station, and near stations.
- Install kiosks with information for TNCs

Promote and facilitate smart phone applications for seamless mobility payment and booking options (T-FAC-3.3)

- Develop or procure MaaS smart phone app to provide seamless plan/book/ride/pay service, either through a Palo Alto “commuter wallet” or a regional collaboration
- Work with regional partners to develop regional MaaS solutions
- Require ride-sharing transportation network companies to share data to support integrated services.
- Embed specific requirements in requests for proposals (RFPs) to encourage utilization of common technology platforms and expand services to diverse neighborhoods and populations
- Provide real-time reporting/dashboard on city travel/corridors

Provide additional incentives for carpooling and vanpooling (T-FAC-3.4)

- Expand the availability and utilization of vanpools, especially targeting shared transportation to dispersed employment sites in Palo Alto from parts of the SF Bay Area (and adjacent counties in the Central Valley and Monterey Bay Areas) that are not especially transit accessible.
- Designate carpool and vanpool parking spaces in City garages.
- Provide discounted parking for carpools, paid parking refund for vehicles parked in public lots or on-street.
- Optimize parking signal timing for GHG reduction
- Model/Pilot having neighborhoods compete to have greatest non-SOV ridership

Goal: Create the right incentives for mobility

Despite the goal in Palo Alto's 1998 Comprehensive Plan to reduce dependence on the private automobile, the City provides free parking in public lots and garages—thus incentivizing driving to the tune for $3600/year[8]—and has plans to build additional parking capacity. Instead, Palo Alto will identify ways (starting with a paid parking study this spring) to phase out automobile subsidies by charging for parking—ideally in coordination with neighboring jurisdictions—and investing the proceeds (as Stanford has successfully done[9]) in alternatives like transit, bicycle infrastructure, ride sharing, walkable neighborhoods, etc.

Strategy	2030 Target	2030 GHG Emissions Reduction
T-INC-1. Provide universal transit passes	75% of residents and employees have universal transit passes	7,600 MTC02e
T-INC-2. Implement parking pricing	100% of City sites and 50% of private sites have parking pricing	18,400 MTCO2e

[8] Amortized cost of providing parking spaces at investment of ~$60,000 per space.

[9] Stanford's program has reduced SOV rates from 72% to 42%, and avoided $107 in capital expenditures for parking structures that were no longer needed. See, for example, http://bit.ly/1RCmSS2

Strategy: Provide universal transit access (T-INC-1)

Expand universal transit pass program for all residents and employees (T-INC-1.1)

- Expand TDM policies to include requirements for the provision of Go-Passes, as well as Eco-Passes (a similar universal transit pass offered by the Santa Clara Valley Transportation Authority) to all residents of existing and new multi-unit buildings in the City, as well as all employees of Palo Alto employers with ten or more employees.
- This strategy is complementary to several other transportation strategies including T-FAC-3 Expand transit facility and services, T-INC-2 parking pricing and management approaches, and T-LU-1 balanced community.

Strategy: Implement parking pricing (T-INC-2)

Have all City employment sites and 50% of private employment sites to institute parking pricing programs and policies (T-INC-2.1)

- Complete and evaluate Paid Parking Study to identify primary recommendations and phasing for reducing or eliminating parking subsidies.
- Pilot voluntary parking cash-out with non-union City employees and change memorandum of understanding with City union employees to allow parking cash-out
- Reduce or eliminate requirements for off-street parking for new commercial/residential development
- Require unbundling parking costs from lease or sale of commercial and residential units
- Use meters/permits or time limits to manage parking demand in congested areas.

Expand paid parking strategies in specific areas (T-INC-2.2)

- Evaluate the use of paid or meter parking strategies for on-street and off-street parking to facilitate parking availability and maximize parking utilization.
- Institute a “free parking surcharge” in select areas, and apply revenues to non-SOV alternatives
- Consider comparable programs for the California Avenue business district, the Stanford Research Park and potentially other districts.

Assess off-street parking requirements (T-INC-2.3)

- Review off street minimum vehicle parking requirements
- Determine whether they can be reduced in situations where building location or design could reduce the demand for parking spaces and where reductions are acceptable in exchange for desired uses such as car-share spaces or alternative fuel vehicle infrastructure.
- Explore “parking maximum” and trip cap requirements

Apply parking revenues to travel and parking demand (T-INC-2.4)

- Evaluate use of parking revenues and the development of a new in-lieu fee program for transportation programs
- Support the downtown transportation management association (TMA) to reduce single-occupancy driving
- Consider using parking revenues to pay for streetscape improvements that make biking, walking and transit more appealing

Goal: Seek balanced development

Palo Alto can potentially reduce commute-related VMT though development patterns that support shorter commutes and complete neighborhoods, by enabling people to live closer to where they work. This is a sensitive

and controversial topic, but its impact is so significant that it must be included here, and discussed and resolved in the community.

Palo Alto has long had an imbalance between jobs and housing, with almost three times as many jobs and employed residents in 2014. This imbalance between jobs and employed residents contributes to local and regional traffic, greenhouse gas emissions, and other impacts, as some workers travel long distances between their residence and workplace. The imbalance is projected to grow if the City does not take affirmative steps to address the issue through the Comprehensive Plan Update. These steps could include:

- Increased housing densities
- Increased areas under existing maximum zoning rules
- Additional regulation of employment densities
- Additional commercial downzoning

This strategy would include adopting a land use and transportation scenario to enable additional growth and development in transit accessible areas, *provided that all such development was designed for low traffic/energy/carbon/water impact* and would be approved only with an integral plan resulting in no in no net increase in vehicle trips to/from Palo Alto. (Mitigation Measure Trans1a in the Comprehensive Plan EIR would provide this type of requirement.)

Strategy	**2030 Target**	**2030 GHG Emissions Reduction**
T-LU-1. Develop zero-impact, mixed-use housing	Target 2.95 jobs-housing ratio[10]	2,900 MTCO2e

[10]This jobs-housing ratio is expressed as the ratio between jobs and employed residents.

Strategy: Increase zero-impact, mixed-use housing (T-LU-1)

Explore "zero impact" standards in residential and commercial development (T-LU-1.1)

- Use sustainable neighborhood development criteria to enhance connectivity, walkability, access to amenities, and support housing diversity
- Accelerate transit-oriented development (TOD) of infill and redevelopment that creates no additional vehicle trips, traffic/energy/carbon/water impact.

Support additional mixed use development (T-LU-1.2)

- Identify and implement strategies to increase housing density and diversity, including mixed-use development near a range of types new community services, through amending the zoning code to allow high-density residential in commercial areas near transit

Identify, as part of long-range planning, potential sites for transit-oriented development with higher allowed density (T-LU-1.4)

- Plan for additional—zero impact—housing units beyond current levels under consideration.
- Areas for potential growth include Stanford Research Park, downtown core, Stanford Shopping Center, as well as additional infill through "backyard cottages" and other accessory dwelling units.

Expand housing options consistent with zero-impact goals (T-LU-1.3)

- Consider creating an amnesty program to legalize existing illegal second units, where consistent with compliance with code standards, and character of existing neighborhoods.
- Emphasize and encourage the development of affordable housing to support Palo Alto's share of regional housing needs.

Prioritize street infrastructure improvements to prioritize GHG emissions reductions (T-LU-1.5)

- Redevelop existing streets to open up street space to prioritize shared modes.
- Embrace "tactical urbanism" to rapidly experiment with different alternatives and learn what works.
- Prioritize traffic signal timing to reduce GHG emissions instead of amount of delay in car travel.

Vehicle Trip Cap:

Mountain View sets *maximum* parking requirements and eliminates minimum off-street requirements, and targets 30-45% single-occupancy vehicle mode share, depending on the density of employment within buildings. One employer faces penalties of $100K for each 1% over the cap. Similar caps are in place in Sunnyvale, Menlo Park and Cupertino.

A mitigation measure in the Comp Plan Draft EIR suggests a similar approach, requiring aggressive TDM plans, with quantitative performance measures and enforcement, as well as requirements to off-set any new trips that cannot be reduced through TDM.

Goal: Reduce the carbon intensity of vehicular travel

Expanding the percentage of trips taken in EVs would have the largest impact on emissions from road transportation, which is in turn the largest category of Palo Alto emissions. Since the city's electricity is 100% from renewable resources, taking steps to encourage all new vehicles purchased to be EVs or other zero emissions technology would significantly reduce emissions associated with on-road vehicles.

Palo Alto already has one of the highest rates of EV ownership in the country (estimated by staff at 3-4% of registered vehicles), but several factors limit EV adoption,

including price (which is dropping rapidly), total cost of ownership (often poorly understood), and vehicle performance— especially "range anxiety."

Initiatives to overcome these barriers, and keep Palo Alto's EV adoption well ahead of the State's aggressive goals, could include: public education, target incentives and charging infrastructure development.

Based on the ratio of jobs to employed residents and an analysis of VMT, approximately 93% of Palo Alto's transportation-related emissions are estimated to be related to trips into or out of Palo Alto for work, shopping and other purposes (i.e. the VMT is not associated with trips that are internal to Palo Alto). An estimated 78% of the total vehicle trips have origins or destinations external to Palo Alto. [11]

Strategy	2030 Target	2030 GHG Emissions Reduction
T-EV-1. Electrify Palo Alto-based vehicles	90% of vehicles in Palo Alto are zero emission	22,900 MTCO2e
T-EV-2. Electrify inbound vehicles	50% of inbound vehicles (non-Palo Alto based) are zero emission	27,000 MTCO2e

Strategy: Explore ways to expand charging infrastructure across Palo Alto (T-EV-0)

Reconvene the electric vehicle supply equipment (EVSE) task force

- Examine how to promote prewiring of EV infrastructure in existing building to remove barriers for future electric vehicle owners

Develop strategies for expanding city-wide EV charging infrastructure.

Develop pricing policies and CPAU rate structures (consistent with legal requirements) for electric vehicle charging at home, in places of business and shopping, as well as in the public right-of-way and parking structures.

Develop an EV promotion roadmap that identifies all policy and technical issues, barriers and opportunities to focus on over the next 3 to 5 years.

Identify grant opportunities, rebates, incentives, and other promotional programs to stimulate electric vehicle ownership and support EV infrastructure, and coordination opportunities related to electric vehicle ownership and infrastructure.

Explore opportunities to partner with major manufacturers like Tesla and Google to identify policy roadblocks and collaboration opportunities.

[11] Estimated 95,742 jobs and 34,428 employed residents. (Source: 2016 Official City Data Set.) Estimates of Internal, Internal-External, and External-Internal VMT and vehicle trips are from the Comp Plan Draft EIR p. 4.13-45. S/CAP allocates road emissions differently than the CompPlan analysis, where emissions from all trips, which are assumed to be round trips, are equally split between inbound and outbound. Since potential strategies available to Palo Alto to affect those trips are different for inbound vehicles than for those based in Palo Alto, the S/CAP allocates these emissions based on trip origination.

Strategy: Electrify and decarbonize Palo Alto-based vehicles (T-EV-1)

Explore time-of-use (TOU) electric rate options for residential customers, including EV customers, residential customers, including EV customers, for residential charging. (T-EV-1.1)

- Develop policies to permit installation of on street electric vehicle charging for private use, including for multi-family dwelling units

Consider rebates or financial incentives for Palo Alto residents (T-EV-1.2)

- Identify grant opportunities, rebates, incentives, and other promotional programs to stimulate electric vehicle ownership and support EV infrastructure, and coordination opportunities related to electric vehicle ownership and infrastructure.
- Develop an EV promotion roadmap that identifies all policy and technical issues, barriers and opportunities to focus on over the next 3 to 5 years.
- Explore providing rebates to Palo Alto residents and employees for electric vehicle and/or EVSE purchases, using Low Carbon Fuel Standard funds, or other funding sources .
- Explore new models for financing EVs in Palo Alto

Seek to convert public transportation vehicles to EVs. (T-EV-1.3)

- Accelerate the electrification of City fleet
- Specify and provide bidding preference for electric or zero emission options for Palo Alto shuttles.
- Work with SamTrans and VTA to encourage the adoption of electric, fuel cell or other zero emission vehicles
- Provide more information about electric vehicles including considerations related to charging infrastructure/programs/policies, vehicle range, lifecycle costs of ownership compared with conventional vehicles

Increase education and outreach related to electric vehicles (T-EV-1.4)

- Provide more information about electric vehicles including considerations related to charging infrastructure/programs/policies, vehicle range, lifecycle costs of ownership compared with conventional vehicles

Strategy: Electrify and decarbonize inbound vehicles (T-EV-2)

Prioritize workplace and retail charging requirements (T-EV-2.1)

- Require and/or incentivize employers to provide workplace charging through reduced parking requirements, or other financial incentives.
- Provide preferential parking for electric vehicles at employment sites and retail/shopping areas

Make it easier to find public charging stations (T-EV-2.2)

- Develop (or encourage private sector firms to develop) smartphone app to show real-time charging information and predictive analytics to indicate likely availability of chargers

Create incentives for high-mileage vehicles to convert to electric or other zero emission vehicle (T-EV-2.3)

- Explore policies and incentives for transportation network companies and car-sharing programs.

BUILDING AN EFFICIENT ELECTRIC CITY

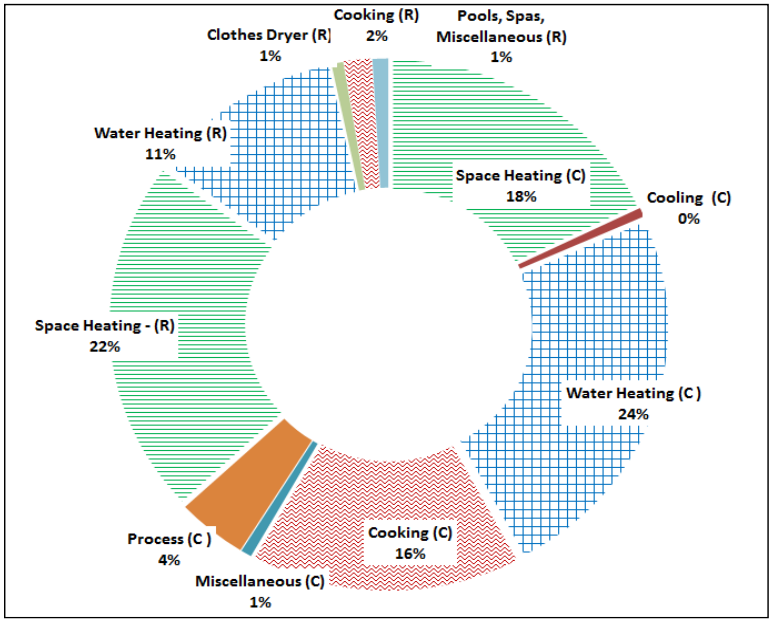
Palo Alto has made remarkable progress in advancing energy efficiency, through CPAU's incentive programs and the City's nation-leading Green Building Ordinances and Energy Reach Codes, and in decarbonizing its electricity sector, through CPAU's carbon neutral electricity (CNE) initiative, which is largely responsible for Palo Alto's remarkable 36% GHG emissions reduction to date. The CNE Resource Plan, adopted in 2013, directed CPAU to eliminate fossil-generated electricity by (1) expanding purchases of long-term renewable energy contracts to about half of Palo Alto's electricity needs by 2017, (2) relying on existing carbon-free hydroelectric resources for the other half of electric supply needs, and (3) purchasing short-term renewable resources and/or renewable energy credits (RECs) to counterbalance emissions from remaining "brown" or "market power purchases until those long-term renewable energy contracts are in the place.

Emissions from natural gas use currently represent ~25% of Palo Alto's remaining carbon footprint.[12] CNE opens to opportunity reduce natural gas use through electrification—"fuel switching" various natural gas uses to electricity—in addition to continued efficiency measures.

The vast majority of natural gas usage is related to today's building stock (existing buildings), with commercial and industrial buildings accounting for 63% of natural gas usage in the City. Palo Alto will first seek to reduce natural gas usage through energy efficiency and conservation, followed by electrification of water heating, space heating and cooking where cost effective. Figure 12 illustrates the estimated distribution of natural gas usage in Palo Alto.

[12] Natural Gas (i.e., methane, is a potent greenhouse gas, with a global warming potential (GWP) at least 23 times that of CO2. Recent research suggests that the climate impacts may be 80-100% higher.

Figure 13: Summary of Natural Gas Usage in Palo Alto Buildings



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The S/CAP roadmap is based on six leverage points:

- *Tenant improvement pathway:* energy efficiency upgrades, and electrification requirements
- *Voluntary retrofit pathway:* Palo Alto Utilities incentive programs (point-of-sale/distributors and contractors), education/outreach
- *Predictive failure analysis:* to anticipate
- *Replace-on-burnout:* develop programs to quickly retrofit with efficient electric equipment, particularly for small businesses.
- *Time-of-sale pathway:* energy efficiency upgrades and electrification requirements
- *Institutional pathway:* removing barriers by streamlining permitting, advocating at the state level to address CEC requirements for cost-effectiveness (so we can require electric equipment), making it easier to "do the right thing" (service and convenience)

Goal: Efficiency and electrification

Efficiency comes first. More efficient buildings require less electricity, natural gas and water, reducing demand on CPAU and saving customers money. Reduced electrical demand from efficiency—even of Palo Alto's already carbon neutral electricity—provides more capacity to meet electricity needs generated by the EV growth and the fuel switching initiatives described below.

Strategy: Encourage advanced efficiency and integrative design, ultimately for Net Zero (or Net Positive) buildings that exceed state minimum requirements for energy efficiency (NG-EE-1)

Develop energy reach code to exceed state minimum for energy efficiency in all new buildings, and all existing buildings doing work that requires a building permit. (NG-EE-1.1)

- Develop energy reach code every 3 years in coordination with building code update; focus efficiency first with carbon as component of policy
- Provide alternate building code pathways for all-electric homes
- Evaluate feasibility of Heat Pump technology in buildings from an electrical as well as cost efficiency perspective.
- Partner with other jurisdictions and NRDC to align energy efficiency and carbon reduction goals in California Energy Commission (CEC) regulations and state policy.
- Increase education and outreach to promote the policy, and to improve ease of implementation and predictability for project applicants

Explore new or expanded programs and policies for energy efficiency in existing buildings (NG-EE-1.2)

- Assess opportunities for residential energy use disclosure requirements
- Explore potential incentives or requirements for energy audits to be completed every 5 years for existing buildings
- Consider time-of-sale requirements for energy upgrades (e.g., Residential/Commercial Energy Conservation Ordinance)
- Continue to expand energy efficiency incentive and technical assistance programs through Palo Alto Utilities to exceed current goals

Goal: Reduce natural gas usage in existing businesses

Reduce natural gas usage through energy efficiency and conservation, followed by electrification of water heating, space heating and cooking where cost effective.

Strategy	2030 Target	2030 GHG Emissions Reduction
NG-COMM-1. Electrify water heating in businesses	50% of commercial water heating is electric	21,200 MTCO2e
NG-COMM-2. Electrify space heating in businesses	50% of commercial space heating is electric	15,900 MTCO2e
NG-COOK-1. Electrify commercial cooking	40% of commercial cooking is electric	11,300 MTCO2e

Strategy: Electrify water heating in businesses (NG-COMM-1)

Determine monthly costs associated with hot water fuel switching (NG-COMM-1.1)

- Using the residential analysis as a template, evaluate the monthly energy costs to consumers associated with switching from natural gas to electric hot water systems. Study should include buildings with both low and high hot water demand.

Assess requirements for major renovations and retrofits (NG-COMM-1.2)

- Study feasibility of including heat pump water heater (HPWH) installations as part of CalGreen Tier 1 and Tier 2 standard

Pilot electric hot water in a high-profile building (NG-COMM-1.3)

- Leverage a high profile City building – such as City Hall – to demonstrate the ability of an entirely electric system to supply all the domestic hot water needs of a large commercial building.

Investigate changes to building code to encourage or if possible require hot water fuel switching for existing buildings (NG-COMM-1.4)

- Explore building code requirements for existing buildings to switch from gas to electric hot water systems upon the end of life of existing gas hot water systems.
- Explore regulatory barriers associated with California Energy Commission cost-effectiveness requirements for ordinances that would require electrification of water heating

Strategy: Electrify space heating in businesses (NG-COMM-2)

Determine monthly costs associated with space heating fuel switching (NG-COMM-2.1)

- Evaluate the monthly energy costs to consumers associated with switching from natural gas to electric space heating systems. Study should include building with both low and high space heating demand.

Pilot electric space heating in a high-profile building (NG-COMM-2.2)

- Leverage a high profile City building – such as City Hall – to demonstrate the ability of an entirely electric system to supply all the space heating needs of a large commercial building.

Investigate changes to building code to encourage or if possible require space heating fuel switching for existing buildings (NG-COMM-2.3)

- Explore building code requirements for existing buildings to switch from gas to electric space heating systems upon the end of life of existing gas space heating systems.
- Study feasibility of including heat pump or resistive space heating installations as part of CalGreen Tier 1 and Tier 2 standard.
- Key leverage points for retrofitting with electric equipment include tenant improvement projects, time-of-sale, replace-on-burnout, voluntary programs and removing institutional barriers such as permitting, etc.

Strategy: Electrify commercial cooking (NG-COOK-1)

Encourage restaurants to switch from gas to electric cooking equipment (NG-COOK-1.1)

- Encourage restaurant owners—through education, hands-on demonstrations and potentially utility incentives—to replace natural gas cooking equipment at end of life and in new restaurants with electric cooking equipment through the provision of incentives.

Host “hands-on” demo events for electric cooking equipment tailored to the restaurant industry (NG-COMM-2.2)

- City hosts events showcasing electric cooking equipment and restaurant owners/chefs who have installed electric equipment to educate the restaurant community on the advantages of these technologies. (Modeled on successful “ride and drive” events for EVs.)

Goal: Reduce natural gas usage in existing homes

Reduce natural gas usage through energy efficiency and conservation, followed by electrification of water heating, space heating and cooking where cost effective.

Strategy	2030 Target	2030 GHG Emissions Reduction
NG-RES-1. Electrify residential water heating	70% of water heaters are electric	13,600 MTCO2e
NG-RES-2. Electrify residential space heating	60% of residential space heating is electric	23,300 MTCO2e

Strategy: Electrify residential water heating (NG-RES-1)

Education and outreach on heat pump water heaters for homeowners. (NG-RES-1.1)

- Provide customers with information on options and cost-effectiveness of heat pump water heaters, including web-based calculator tools

Educate contractor and installer workforce (NG-RES-1.2)

- Inform and educate water heater installers about heat pump technologies. Explore options for trainings or advertise trainings available.
- NG-RES-1.3. Funding and incentives for heat pump water heaters
- Explore funding sources for heat pump water heater rebates for customers, as well as funding sources to incentivize installers to offer heat pump water heaters as a default option.

Explore a 24-hour emergency hot water heater replacement program (NG-RES-1.4)

- Explore developing a streamlined process to assist Palo Alto residents with replacing water heaters upon—or before—failure, with heat pump water heaters in a.

Utilize building data to target programs. (NG-RES-1.5)

- Explore development of an analytic process that would enable staff to predict the life expectancy of older water heaters based on past building permit data and use these predictions to target promotion and installation of heat pump water heaters before natural gas water heaters reach end of life.

Strategy: Electrify residential space heating (NG-RES-2)

Explore feasibility and economics of retrofitting multi-family buildings (NG-RES-2.1)

- Target multi-family buildings that presently have electric baseboard heating to approach with heat pump space heating technologies.

Provide resources to homeowners to convert existing homes to all-electric (NG-RES-2.2)

- Compile list of qualified architects, develop case studies, set up communication channels for homeowners to share ideas and host workshops on electrifying existing homes.

Provide funding sources for electrifying existing homes (NG-RES-2.3)

- Explore feasibility of new funding sources and incentives to electrify existing homes on a pilot scale.

Develop retail electric rate schedules for homes that electrify (NG-RES-2.4)

- Evaluate all-electric rate schedule for residential customers as part of the upcoming electric cost of service analysis; if feasible, recommend such retail rates for Council consideration and approval.

Goal: Reduce natural gas in new buildings

New construction offers a unique opportunity to build zero net energy buildings with low incremental costs. With the new California energy code requirements and the plummeting price of LED bulbs, the only real cost to a homeowner is the cost of a solar PV system, which is also dropping rapidly.

California is requiring “net zero energy” for all new residential construction by 2020, and all new commercial construction by 2030. Palo Alto is currently considering whether and how to accelerate those deadlines in the next Green Building Ordinance.

Strategy: Encourage all-electric new buildings (NG-GAS-1)

Strategy	2030 Target	2030 GHG Emissions Reduction
NG-GAS-1. Encourage all-electric new buildings	New buildings are zero net energy ahead of state targets	11,900 MTCO2e

Expand programs for incentives for zero net energy new buildings (NG-GAS-1.1)

- Continue to develop energy efficiency programs targeted at new buildings that meet specified energy use intensity targets appropriate for the Palo Alto climate zone.

Provide technical assistance and educational resources for all-electric zero net energy buildings (NG-GAS-1.2)

- Provide additional educational and outreach programs related to all-electric building design strategies and technologies for architects, design teams and contractors.

Require new homes to be zero net energy ahead of state goals (NG-GAS-1.3)

- Explore legal/regulatory ramifications of all-electric buildings without natural gas hookups.
- Explore additional residential and commercial building code changes for new construction and remodeling projects to expedite electrification.

Explore requirements for all-electric new construction. (NG-GAS-1.4)

- Explore building code requirements for electric water and space heating in all new commercial buildings.
- Explore feasibility of requiring all-electric construction in new buildings and/or major renovations

Goal: Reduce the carbon intensity of natural gas

Similar to the approach utilized for carbon neutral electric supply, Palo Alto will continue to explore opportunities to procure biogas and/or carbon offsets in the short term in order to "green the gas" while we work towards reduced natural gas consumption and infrastructure. Carbon offsets and biogas supplies should be evaluated and monitored in parallel with electrification and progress on reductions in natural gas consumption in Palo Alto to ensure that the City meets its 2030 targets.

Strategy: Eliminate natural gas emissions with carbon offsets or biogas (NG-OFF-1)

Make PaloAltoGreen Gas program opt-out (NG-OFF-1.1)

- PaloAltoGreen Gas program is currently an opt-in program, which limits participation. The program should be modified as an opt-out program, providing flexibility to customers who truly do not want to participate.

Consider carbon offsets to offset remaining GHG emissions. (NG-OFF-1.1)

- After all feasible measures are taken to reduce natural gas consumption, utilize carbon offsets – either by making the PaloAltoGreen Gas an "opt-out" program or the purchase of carbon offsets by the City.

Procure biogas supply. (NG-OFF-1.2)

- Palo Alto will continue to assess opportunities to incorporate biogas (Renewable Natural Gas) supply into the natural gas mix.

ZERO WASTE AND THE CIRCULAR ECONOMY

Reducing the amount of waste discarded in landfills is an important strategy for both greenhouse gas reductions and overall sustainability. Diverting waste from landfills occurs through product changes, material use reduction, reuse, recycling and composting. .Equally important, these diversion strategies will create a "circular economy" where materials, water and energy do not create waste or pollute, but rather contribute their value back into a sustainable, circular cycle of human and ecosystem activity.

Achieving a "zero waste" will require reducing the overall amount of waste generated within the City—through purchasing decisions and material use reduction (and ultimately product design), as well as more effective sorting, recovery and recycling.

In 2007, the City completed a Zero Waste Operational Plan established a goal of 73% diversion by 2011 and 90% by 2021— well beyond state requirements[13]. This new S/CAP sets a new goal of 95% Diversion by 2030.

Goal: Achieve 95% landfill diversion by 2030, and ultimately zero waste

Strategy	2030 Target	2030 GHG Emissions Reduction
SW-1. Achieve zero waste	Achieve 95% diversion rate	9,500 MTCO2

[13] California Assembly Bill 939 was passed in 1989, and mandated local jurisdictions to meet a solid waste diversion goal of 50% by 2000. Furthermore, each jurisdiction was required to create an Integrated Waste Management Plan that looked at recycling programs, purchasing of recycled products and waste minimization.

Strategy: Enhance policies and programs for recycling, composting and reuse (SW-1)

Increase education and outreach for existing waste diversion programs (SW-1.1)

- Promote existing programs, including City's Household Hazardous Waste Program, through aggressive outreach, initiatives and extended producer responsibility (EPR) initiatives.

Reduce the number of non-recyclable or non-compostable materials in the community (SW-1.2)

- To the maximum extent practical, utilize the municipal code to restrict non-recyclable or non-compostable products sold in the City
- Work with partner agencies and the business community to develop producer-funded take-back programs.
- **E**ngage local businesses to increase the number of companies participating in the program and adopting best practices related to food waste, landscape waste and recycling.

Partner with local agencies to promote recycling and reuse (SW-1.3)

- Partner with local non-profits (e.g., Goodwill) to boost efforts in material reuse and exchange
- Support Bay Area Green Business Certification program that requires adoption of waste reduction practices

Revise and implement new more stringent C&D ordinance recovery measures (SW-1.4)

- Work with stakeholders and regional waste recovery facility management to increase the City's existing C&D recovery percentage requirements.
- Emphasize on site reuse or off site salvaged to provide a higher and better use for the materials than recycling or disposal.

Strategy	2030 Target	2030 GHG Emissions Reduction
SW-2. Implement an energy savings and pollutant reduction strategy for waste collection vehicles	100% electric (or low-carbon fuel) waste collection vehicle fleet	Zero GHG emissions (if electric vehicles available)

Strategy: Implement an energy savings and pollutant reduction strategy for waste collection vehicles (SW-2)

Utilize electric or alternative fueled waste collection vehicles as soon as possible (SW-2.1)

- Change to a 100% CNG fleet in the next (2021) waste collector agreement.
- Monitor the availability of electric collection vehicles, and introduce them as rapidly as feasibile.

Eliminate the separate collection of garbage (SW-2.2)

- As the City moves closer to zero waste, more of the waste materials collected should be recoverable (recyclable or compostable), evaluate eliminating separate collection of garbage, and moving to a two-cart collection scheme.

Minimize transportation and manage the City's waste as locally as possible (SW-2.3)

- Track developments in processing technology to identify options that could be implemented at local or regional locations.

GETTING SMART ABOUT WATER

Palo Alto has done an outstanding job of meeting annual water use reduction requirements of the current "drought." But both potable water supplies and hydroelectric needs could be challenged by long-term shifts in California's precipitation regime.

With shifting climate patterns[14], significant uncertainty exists about whether drought conditions are the "new normal" for California, with a possible "new normal" of less (and less reliable) precipitation. Moreover, most climate projections show increases in average temperatures and reduced snowpack where Palo Alto sources much of its water—which could impact Palo Alto's hydroelectric power and thus its carbon neutral electricity strategy.

Given current climatic projections, long-term increases in water supplies from San Francisco Public Utilities Commission (SFPUC) appear highly unlikely. It would be prudent to reduce water consumption while exploring ways to increase the availability and use of recycled water.

Goal: Reduce consumption of potable water

CPAU water demand management measures (DMMs) have supported customers in reducing water use 27% between 2000 and 2010. CPAU's drought response programs have enabled the City to reduce water use by 24% in 2015 compared with 2013 levels, far ahead of the State's mandated reduction requirements. Long-term water reduction strategies should focus not only on implementing these procedures during times of drought, but rather using the incentives and policy drivers listed in the water management plan to drive sustained water consumption reduction.

[14] The California Department of Water Resources (http://www.sei-international.org/news-and-media/3252), the Association of California Water Agencies (http://www.acwa.com/events/2016-executive-briefing-defining-new-normal) and others are examining the potential impacts of Climate Change on Hydrologic Trends and Water Management.

Strategy: Strengthen policies for community-wide water conservation and water efficiency (W-1)

Provide increased funding for landscape conservation rebate program to drive participation in program (W-1.1)

- Supplement existing funding for the landscape conservation rebate program in order to offer additional rebates for Palo Alto residents and businesses beyond the $2.00 per square foot offered by SCVWD. Increasing rebates to $3.00 - $4.00 per square foot will drive increased participation in the program.

Develop landscape water budgets and link to block rates to discourage excessive water consumption (W-1.2)

- Develop landscape water budgets for high-use customers based on landscape area, plant materials and climate condition.
- To the extent feasible, link landscape water budgets to tailored block rate schedules to encourage conservation.

Develop long-term efficiency goals, and aggressively market toward them (W-1.3)

- Set long-term, strategic targets for increased installation rates of water efficient fixtures and appliances and use a variety of marketing techniques – hardware swaps, replacement programs, rebates and incentives – to achieve these targets.
- Develop and implement water efficient landscape and indoor water regulations

Incorporate net zero water standards in future Green Building Ordinances (W-1.4)

- Build net zero water standards into future Green Building Ordinances.
- Achieve that goal through a combination of rainfall harvesting, aggressive conservation, and water recycling, and buildings that can achieve self-sufficiency from the water “grid”.

Evolve Palo Alto landscapes to adapt to changing precipitation trends, and allocate water resources to protect our urban canopy (W-1.5)

- Emphasize incorporation of drought-tolerant and drought-resistant plants and landscape design into publically owned land – including parks, school yards and medians.
- Educate and incent CPAU customers to adapt and evolve their landscapes.

Goal: Supplement existing water supplies

In addition to reducing potable water consumption, Palo Alto will seek to supplement existing SFPUC water supplies with “new” sources, to provide redundant supplies that strengthen resilience and water security, including: 1) increasing local water capture, 2) maximizing the potential for water recycling and 3) exploration of decentralized, on-site waste water treatment.

Net Positive Water

What if Palo Alto, or specific buildings, could capture more water than it used? What would it take? What would it look like?

Strategy: Supplement SFPUC water supply with other sources of potable and non-potable water (W-2)

Create and implement a Green Infrastructure Plan that prioritizes green streets infrastructure (W-2.1)

- Create policies that integrate the design of green infrastructure into City and private sector projects to store, infiltrate, cleanse and evapotranspire stormwater.
- Expand permeable paving and reduce impermeable paving.
- Increase rainfall infiltration, replenish groundwater, utilize soil to filter pollutants, increase habitat, retain and detain stormwater and meet State and Federal permit requirements
- Utilize: bioswales, raingardens, infiltration basins, retention basins, rain barrels cisterns, green roofs, vegetation, and permeable blocks, pavement and systems.

Incentivize water harvesting and downspout disconnections (W-2.2)

- *Provide education, support and incentives to promote the capture of rainwater and greywater to be utilized for landscape and other water needs.*
- *Require and/or incentivize the disconnection of downspouts to redirect water to landscapes, rain barrels, cisterns, or permeable areas – instead of the storm drain.*

Expand recycled water capacity and uses (W-2.3)

- Continue to investigate methods for expanding water recycling from the RWQCP, including: facility upgrade at the Plant, increased delivery to Mountain View, new delivery to East Palo Alto and other RWQCP partners, and interties to the North and South of the RWQCP service area
- Continue to explore expansion of purple pipe infrastructure within Palo Alto
- Explore new uses for recycled water including the production of purified (potable) water groundwater storage/recharge, and ultimately direct potable reuse.

Explore and pilot advanced technology water recycling technologies, including onsite treatment, and energy, water and materials harvesting from wastewater (W-2.4)

- Investigate the potential of onsite wastewater treatments systems that enable property owners to treat and reuse wastewater on site.
- Investigate NASA, Stanford and other onsite water treatment technologies for possible pilot at City Hall
- Explore beneficial use of wastewater biosolids, including anaerobic digestion, gasification, pyrolysis, including various uses for the energy produced, such as microbial fuel cells and hydrogen production
- Phase out incineration of biosolids by 2019.
- W-2.5 Evaluate potential for large scale water storage beneath parks, schools, paring lots, etc.
- Study the feasibility of large-scale underground water storage that enables rapid storage of water during large precipitation events that would otherwise be destined for storm drains.

Beneficially Reuse 100 % of the treated wastewater from the RWQCP (W-2.5)

- Evaluate minimum flows and maximum nutrient/pollutant loadings for Bay Discharge
- Evaluate benefits and amounts of discharge to local marsh systems, creek augmentation, sea level rise mitigation and groundwater infiltration/injection
- Combine results with W-2.3 explorations to insure that 100% of the wastewater is ultimately used to benefit human and ecosystem needs

MUNICIPAL OPERATIONS – LEADING THE WAY

The City of Palo Alto has long demonstrated its commitment to sustainability and reductions of greenhouse gas emissions through its municipal operations. Palo Alto city government's environmental footprint is small—3.1% of citywide electricity use, 2.9% of natural gas use and 5.3% of water use in FY 2014. But resource efficiency, low carbon and other sustainability initiatives can save money, improve operating performance, reduce emissions, and provide leadership by for the community. And the City has an important role in both leading by example has a powerful impact, both by providing a governing framework that supports sustainability throughout the community and inspiring within out community and to neighboring communities. The city government's commitment: "We walk the talk, and we go first."

Goal: Efficient City Buildings

The City spends approximately $6 million annually on utilities; "typical" 10-20% potential efficiency savings could result in more than $600,000 saved per year. The City requires LEED certification for all new City buildings over 10,000 square feet, and assessment of "green building" potential for substantial renovations and additions over 5,000 square feet. These requirements may not have captured all opportunities, and advances in green building design and technology continually open new ones.

Strategy: Use City Buildings as Demonstration Projects for Advanced Building Technologies

- Explore opportunities to electrify existing and new City buildings, including utilizing heat pump water heaters and heat pump space heating technologies.
- Require LEED™ Gold or Platinum certification for new City buildings, and at least LEED certification for retrofits.[15]

Strategy: Develop a Facilities Master Plan for City buildings

- Analyze resource consumption in City buildings to identify priority opportunities for efficiency gains and management improvements.
- Identify capital improvement goals, and methods for ensuring sustainability and efficiency goals are embedded in the capital improvement process.
- Provide criteria for Facilities, Engineering and the Sustainability Office to use to guide inter-division coordination and collaboration, and evaluate City performance, and will include:
    - *A Long-term energy management plan*
    - *Energy efficiency standards*
    - *Processes for retro-commissioning and performance benchmarking to incentivize and ensure high performance that matches design*

[15] Palo Alto currently requires LEED silver for new construction (as do many cities). San Francisco and Vancouver require LEED goal.

- *Long-range capital improvement plan*
- *Budgetary goals*

Goal: Efficient City Fleet

Strategy: Continue to electrify city fleet vehicles where possible

- Develop protocols to systematically shift City fleet vehicles to electric where appropriate
- Continue to explore third-party providers of EV charging infrastructure, as a potential way to expand that infrastructure at minimal cost to the City.

Strategy: Explore new models for City fleet vehicle operations

- Explore partnership opportunities between City fleet and car-sharing companies (e.g., performance contracts, and/or and making fleet available for public rental after business hours)16
- Consider piloting use of self-driving vehicles as part of City vehicle fleet

Goal: Procurement—"Default to Green"

In 2007, the City authorized the implementation of a green purchasing program, and subsequently adopted a Green Purchasing Policy (GPP) in 2008, which supports existing environmental policies and Council direction to reduce GHG, pesticides and mercury, and achieve Zero Waste and pollution prevention goals. In 2015, the City Manager established a "default to green" strategy that makes the greener product the norm rather than the exception. Staff will always have the option to purchase alternative products, wherever cost or performance requirements make the green product in appropriate, but by making the greener purchase easier, and supported by tools that assist staff in choosing the best option, the City hopes to embed greener purchasing in to City processes. (This has been accomplished for paper and toner purchases, and is underway for fleet purchases.)

[A 2014 OSS analysis showed that the Scope 3 GHG impacts of City purchases would add an estimated 25% to City government emissions.]

Strategy: Continue to update and expand GPP awareness

- Establish additional GPP criteria in all priority procurement categories
- Work with vendors and allies to develop clear support material for City staff
- Provide green procurement training and tools to City procurement staff

Strategy: Optimize allocation of funds to support GPP implementation

- Allocate funds to develop or acquire "green purchasing" management and tracking software
- Allocate funds and/or staff for at least 30%FTE to implement current green purchasing plan (from ASD, CMO, or PWD) which includes annual reporting and tracking;
- Allocate 25% FTE of ASD Purchasing Staff to assist with program implementation
- Report progress at least annually.

Goal: Embed Sustainability in Management Systems and Processes

Wherever possible, the City will embed sustainability criteria in City management systems, to ensure that the concerns identified in this Plan are addressed early, as part of standard operating procedure rather than special "sustainability add-ons."

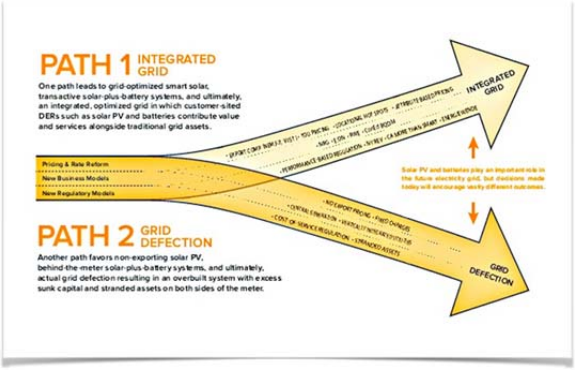
[16] As, for example, ZipCar has done with New York, Houston and other cities

Strategy: Infuse sustainability throughout City operations

- Embed sustainability commitments and criteria into CIP process, and specification and management of building construction, renovation and operation
- Incorporate a "sustainability impacts" section into standard staff report templates.
- Establish internal carbon targets, pricing and trading to increase GHG-reduction[17]
- Provide relevant sustainability training modules through the City's training systems.

[17] According to the World Bank, more than 150 companies, 40 countries and 20 cities have instituted carbon pricing. http://www.worldbank.org/en/programs/pricing-carbon

PALO ALTO'S UTILITY OF THE FUTURE



The utility industry is changing. Rapidly dropping costs of renewable and distributed power sources, energy storage, electric vehicles and energy-related telecommunications are combining to challenge the traditional utility framework and business. CPAU is tracking these trends, has begun piloting residential "smart meters" in a few hundred locations and begun assessing the load and storage impacts of electric vehicles on the grid. These trends intersect sustainability and climate action concerns, and raise both significant challenges and opportunities for CPAU.

CPAU will explore and evaluate the "Utility of the Future" concept—including potentially moving from a centralized utility provisioning model to a more agile one of greater embracing distributed energy generation and storage, an increased focus on energy services in addition to energy generation and distribution.

Goal: Implement innovative efficiency strategies

As discussed above, efficiency comes first. CPAU has successfully delivered a suite of efficiency products and services for years; new approaches to delivering efficiency may be need to both meet carbon goals and ensure capacity to meet future needs.

Strategy: Continue to incorporate energy efficiency as the highest priority resource

- Procure energy efficiency as a resource (e.g. negawatts)—and a tradable commodity—to access funds based on levelized marginal cost rather than total resource cost (TRC).
- Promote—and monetize—radical resource efficiency
    - *Apply retro-commissioning and performance benchmarking to incentivize and ensure high performance that matches design*
    - *Develop integrated utility service offerings (including electric vehicles, solar and energy efficiency), with predictive analytics and on-bill financing*

- Promote energy efficiency and conservation through both outreach and financial incentives and repayment programs (education, outreach, on-bill financing/repayment, incentives, etc.)

Strategy: Evaluate and advance appropriate electrification strategies

- To the extent feasible, adopt electric and natural gas rates and tariffs that support fuel switching, and that provide the right incentives for where we want to go now.
- Maintain integrity of natural gas infrastructure as natural gas revenues decline.

Strategy: Evaluate and advance appropriate distributed generation strategies

- Develop a long-term plan for Integration of high levels of distributed resources into the system to promote low carbon energy and reliable and cost effective delivery.
- Address to potential challenge of "grid defection," for example through rate policy (feed in tariffs), service offerings (provide/manage/finance local generation and storage), etc.
- Improve and maintain the resilience of the power grid, as well as natural gas, water, wastewater distribution systems.

Goal: Advance smart grid strategies

Smart grid strategies connect to Palo Alto's existing, smart city and open data strategies, and offer the promise of more responsive and efficient energy systems, and more connected and satisfied customers.,

Strategy: Deploy Smart Grid as key part of "smart and connected city"

- Implement real-time metering for all customers to match costs with power pricing
    - *Conclude smart meter pilot and roll out smart meters city-wide by 202X.*
    - *Provide customers easy, real-time access to their utility data through Green Button and other APIs*
- Provide incentives for—or provision and manage—localized or neighborhood storage
- Develop smart micro-grid and nano-grid strategies to integrate electric vehicles, energy storage, renewable generation and islanding protection from blackouts.

Goal: Evaluate and adapt the CPAU business model

The utility industry faces a potentially disruptive future—driven by changing technology, economics and customer expectations, as well as policy changes—that could include the challenge of "grid defection" as customers become their own providers, and of new regulatory models and new competitors that shift revenues from utilities to other participants in the energy system. Few utilities have begun to consider how to adapt to the creative destruction in by the proliferation of distributed generation and energy efficiency; many are actively resisting the transition. CPAU, small and locally controlled, has the capabilities to rapidly evolve the business models these trends are demanding.

Strategy: Consider long-term CPAU strategy in light of rapidly changing technology

- Carefully consider and decide what fundamental value CPAU will deliver to its customers:
    - *Buy, broker and distribute energy*
    - *Sell benefits, not resources*
    - *Deliver efficiency services*
    - *Own and manage distributed generation & storage capacity*
    - *Sell management, services, financing & data*

- Develop options to adapt business model to changing industry dynamics and proactively explore "utility of the future" strategies to take advantage of potential disruptive change facing the industry.
- Develop an agile, service-focused (rather than commodity-focused) business model, including
- Develop long-range plans to meet Palo Alto's goals for sustainability, economic prosperity, and continued quality of life in the face of changing market conditions and customer expectations
- Evaluate the potential regulatory barriers and possible implications of electrification strategies, including impacts of potential decline in natural gas use on CPAU revenues

Strategy: Leverage the resiliency and potential cost benefits of distributed energy resources (e.g., solar, storage, microgrids)

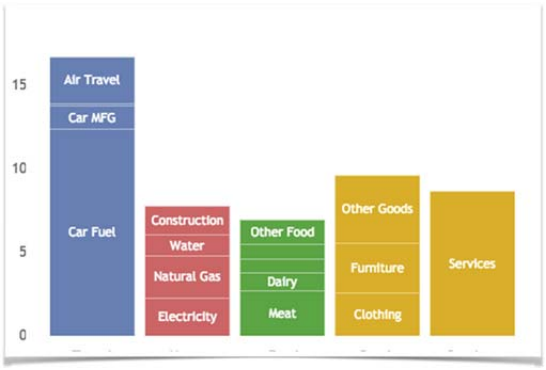
- Maximize local solar+storage as resilient complement to grid solar.
- Explore microgrid and district energy strategies in key districts

Goal: Continue to advance carbon neutrality

CPAU will continue to play a central role in Palo Alto's carbon neutrality trajectory.

- Continue to support electrification programs and requirements identified in the S/CAP to effectively draw down the use of natural gas, including:
    - *Restructure rates to not penalize increased electrical demand*
    - *Prepare to upgrade grid to meet rising demand from electrification.*
- Develop hydroelectric power contingency plans
    - *Ensure maintenance of carbon neutral electricity in face of potential reduced reliability of hydroelectric power*
    - *Increase renewables power procurement to hedge hydro uncertainty, subject to the City's Risk Management Policies and Procedures*

COMMUNITY BEHAVIOR, CULTURE & INNOVATION



Ultimately the way individuals and businesses act dictates our consumption patterns and thus our impact on natural resources. To truly address the challenges of climate change and sustainability, individual behavior will have to continue to change. In fact the GHG impact of individual purchasing decisions—not reflected in Palo Alto's GHG inventory, above—is significant. (See Figure 14, below.) Achieving that change will require broad community engagement, participation, guidance— and individual initiative. To support that, the City will active inform & convene stakeholders, support individual & collaborative action, and disclose and report impacts of both City and community-wide initiatives and impacts.

[Graphic: stages of behavior change?]

Goal: Provide a platform for community change in culture, behavior and innovation

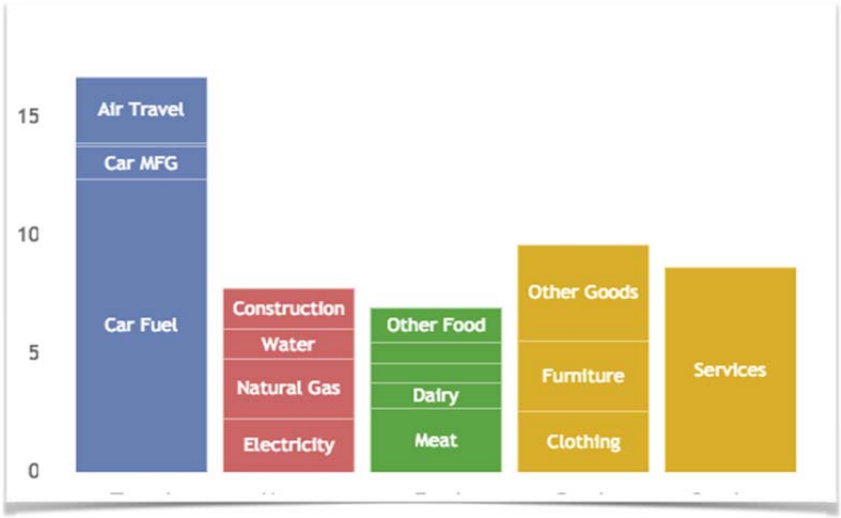
Strategy: Changing Cultural Norms

- Inform & convene stakeholders, support individual & collaborative action, and disclose and report impacts of both City and community-wide initiatives and impacts.
- Develop awareness and understanding community-wide to the relevance of actions to reduce energy consumption, switch to cleaner sources of energy, embrace non-auto based mobility options, and reduce both water and solid waste.
- Foster experimentation, alliances, design competitions, hackathons and big leaps led by our local residents, businesses and community stakeholders.

Strategy: Facilitate personal and neighborhood action

- Pilot "CoolBlock" collaborations to support neighborhood cooperation toward sustainability and resilience goals
- Pilot neighborhood competitions to reduce single-occupancy vehicle travel, with opportunities for City of Palo Alto to pilot street improvements to facilitate walking/biking/transit
- Deploy/encourage performance dashboards and "fitbit for sustainability" apps
- Estimate/report "scope 3" emissions, to seed conversations about consumption

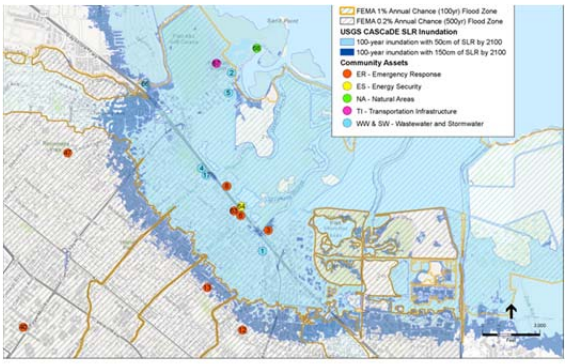
Figure 15: Palo Alto Per Capita GHG emissions, including "Scope 3" Impact of Purchases



Strategy: Develop Smart City and Power of Open Data

- Extend open data initiatives to include mobility, utility, operations & environmental quality
- Provide visual performance dashboards that simplify tracking and benchmarking sustainability performance—and support effective action
- Provide real-time reporting/dashboard information on key city arterials and corridors providing information on real-time mode share of driving, biking, pedestrian activity
- Accelerate smart grid deployment.
- Enable customer and 3rd party access to accurate, timely data.
- In all these, ensure reliable protection of privacy.

CLIMATE ADAPTATION: PREPARING FOR CHANGE



The first imperative of climate change planning is mitigation, the reduction in the emissions of greenhouse gases so that the impacts can be kept as small as possible. However, even if all carbon emissions were stopped today, some of these effects are likely to continue for decades into the future. Palo Alto's greatest climate change risks are a product of the City's bayside setting, the inherent sensitivities of its Mediterranean climate, and its dependence on imported water from the distant Sierra Nevada mountains as its primary water and hydro- electric supply.

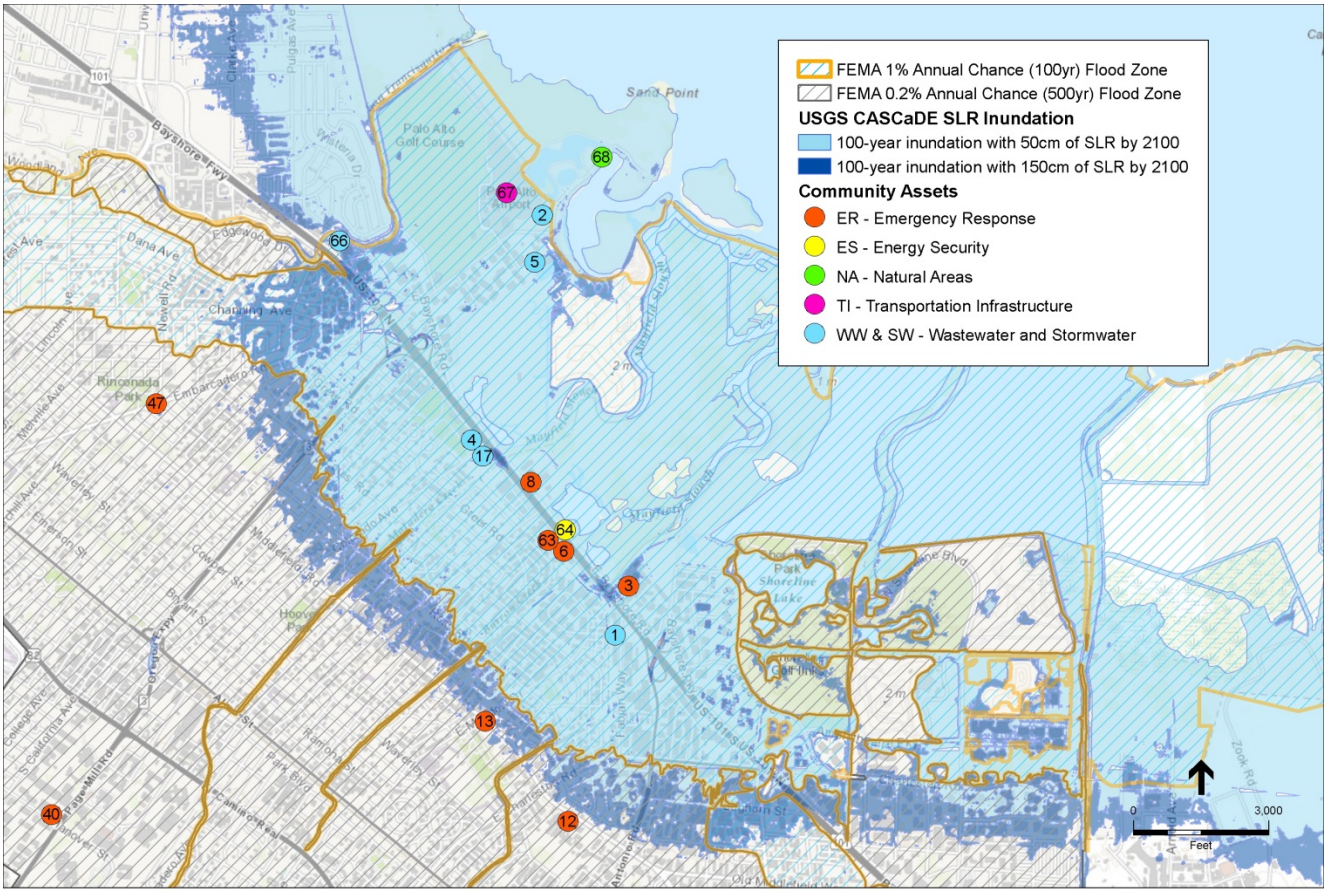
Sea-level rise is expected to affect low-lying areas of Palo Alto surrounding the San Francisco Bay with more frequent and severe flooding. The State of California has adopted guidance and planning sea level rise projections for the San Francisco Bay region from the National Research Council (NRC, 2012[18]) of projected 11 inches of sea level rise by 2050 (with a range of 5 to 24 inches) and 36 inches by 2100 (with a range of 17 to 66 inches by 2100.[19]

[18] National Research Council (NRC), 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.* http://www.nap.edu/catalog.php?record_id=13389

[19] California, via the Ocean Protection Council, (OPC, 2013[19]), has adopted the San Francisco Bay region sea level rise projections from the National Research Council (NRC, 2012[19]), which includes an allowance for vertical land motion.

Figure 16 and **Figure 17** provide an overview (leveraging Silicon Valley 2.0, a regional planning effort to minimize the anticipated impacts of climate change) of community assets identified at risk of sea level rise/flooding and fire risk. (See detailed assessment of risks and potential responses in Appendix XX.) City staff have several related work streams underway.

Figure 16. Palo Alto Community Assets at Risk from Sea Level Rise and Associated Flooding

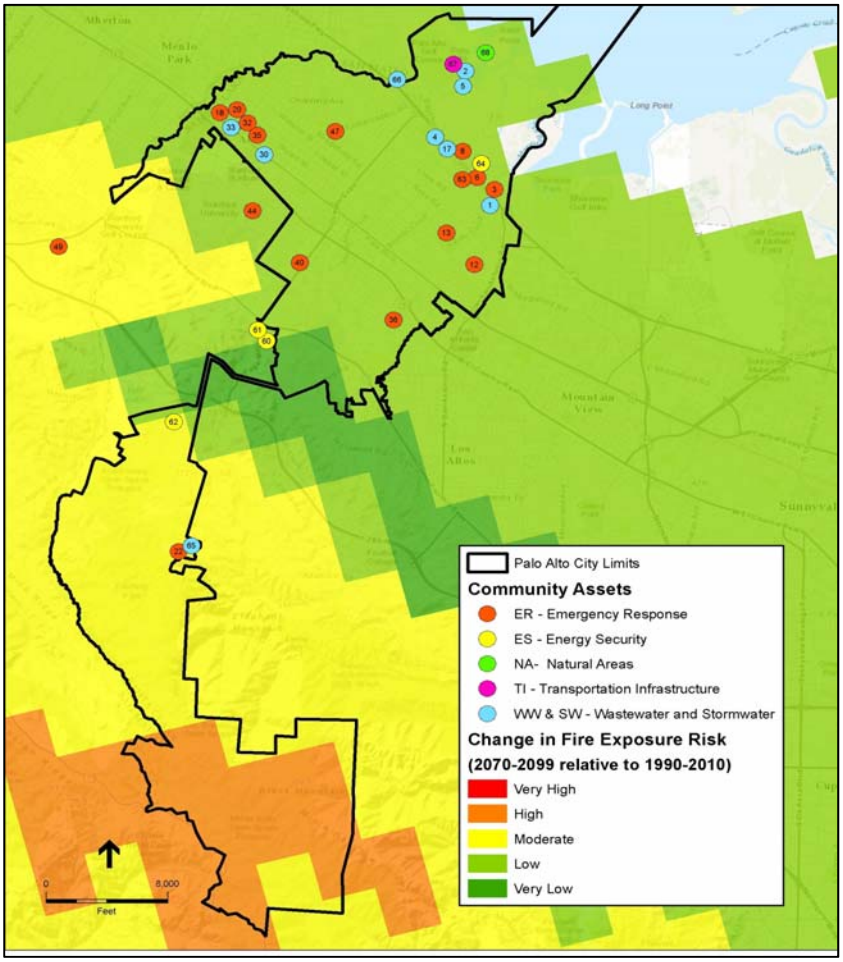


SOURCE: USGS (SLR inundation), FEMA (flood zones), City of Palo Alto (City Limits, asset locations), ESRI (basemap background)

City of Palo Alto SCAP . D140455.00

Palo Alto Flood Risk and Community Assets Map

Figure 17. Change in Fire Exposure Risk, Showing Community Asset Locations



Guiding Principles for Sea Level Rise Response

Recognizing the most immediate risks related to sea level, particularly for critical facilities along the San Francisco Bay Shoreline, Palo Alto has identified six guiding principles[1]:

(1) For city of Palo Alto capital projects, use sea level rise assumptions consistent with the State of California adopted guidance, with a minimum of 55 inches based on Bay Conservation Development Corporation (BCDC) numbers.
(2) Continue to monitor latest climate change and sea level rise science and adapt as needed if sea level rise occurs at a more rapid pace and/or higher levels than projected
(3) Ensure engineering solutions are adaptable to changing climate predictions
(4) Consider tools to protect, adapt and retreat as appropriate and cost-effective
(5) For areas that are to be protected, consider additional tools in case severity and speed of sea level rise increase, such as designing structure that can get wet and locating sensitive equipment higher in a building
(6) Continue to collaborate with regional planning efforts on studies of climate impacts and strategies to respond to sea level rise

Goal: Protect, Adapt, Retreat

Strategy: Protect Municipal Services Center, Utility Control Center and Utility Control Center

- Review long-term plans to protect these assets, including potential relocation, or establish additional redundant operational capabilities in case these facilities become incapacitated during a flooding event.
- Assess foothills communication towers in the foothills for vulnerability to wildfire. Update emergency preparedness plans accordingly.

Strategy: Enhance Energy Security and Infrastructure

- Action: Develop an energy resiliency plan focusing on building in resiliency and lessening the impact of statewide and regional energy events.
    - Adaptation measures would include islanding, smart grid, local generation, energy storage and redundant transmission lines.

Strategy: Water Supply

- Action: Continue aggressive water conservation programs
- Action: Set higher conservation goals in the 2015 update to the Palo Alto Urban Water Management Plan
- Action: Participate in in regional planning efforts by the Bay Area Water Supply and Conservation Agency, Santa Clara Valley Water District and San Francisco Public Utilities Commission.
- Action: Investigate potential alternative supplies, including recycled water and use of local groundwater sources.

Strategy: Wastewater Management

The greatest risk to the City's wastewater management is potential failure of existing levees that protect the RWQCP from coastal flooding associated with sea level rise by 2100.

- Action: Evaluate feasibility of "horizontal levees," and opportunities to incorporate treated wastewater effluent in their creation.
- Action: Develop a flood proofing plan for the RWQCP that minimizes impacts to the site in the event of local inundation.

Strategy: Stormwater Management

- Action: Coordinate creek flood management planning with the SAFER coastal flood management project that is just getting underway.
- Action: Assess opportunities to integrate stormwater into the wetlands rather than segregating it in stormwater channels and detaining it in flood basins, in order to create a more resilient shoreline.

Strategy: Transportation Infrastructure

Highway 101 (Bayshore Freeway), the Palo Alto Airport, and surface streets in the Palo Alto floodplain are all at significant risk from sea level rise by the year 2100. Current levees are not likely to adequately protect these assets from sea level rise; the SAFER Bay project is planning improvements to these levees.

- Action: Assess the vulnerability of Highway 101 (Bayshore Freeway), the Palo Alto Airport, and surface streets in the Palo Alto floodplain to sea level rise by the year 2100.
- Action: Better define adequacy of current levees to protect these assets from sea level rise, along with consequences of failure and contingency plans in the event they become damaged or inaccessible.
- Action: Assess the vulnerability of roads and highways in the foothills for wildfires by the year 2100.

Strategy: Public Health

The City's most vulnerable populations (elderly, low-income and health-compromised residents) face significant risk from extreme heat events by 2100, and higher risk of health problems from worsening air quality and new disease vectors.

- Action: Engage the public and promote community involvement in actions to reduce climate change risks, using linguistically and culturally appropriate approaches that are effective for diverse populations.
- Action: Reduce urban heat islands (also has energy conservation/GHG co-benefit).
- Action: Partner with organization like Cal-BRACE (Building Resilience Against Climate Effects) to forecast climate impacts and assess public health vulnerabilities, educate and engage more effectively with the community, assess current strategies, and identify effective responses.
- Action: Engage with and seek support from Association of Bay Area Government's (ABAG) community resilience programs; in particular their multiple hazard risk assessment and study of housing resilience in the face of natural disasters.

Strategy: Continue to work with regional partners to implement integrated resiliency approaches

- Promote and participate in cooperative planning with other public agencies and regional and adjacent jurisdictions, especially regarding issues related to climate change, such as water supply, sea level rise, fire protection services, emergency medical services, and emergency response planning.
- Develop new requirements for shoreline development to ensure that new development is designed and located to provide protection from potential impacts of flooding resulting from sea level rise and significant flood events.
    - Requirements could include: new setbacks to ensure to structures are set back far enough inland that they will not be endangered by erosion; limits on subdivisions and lot line adjustments in areas vulnerable to sea level rise to avoid the creation of new shoreline lots; incentive or transfer of development rights (TDR) programs to relocate existing development away from high risk areas; and/or triggers for relocation or removal of existing structures based on changing site conditions and other factors.

Strategy: Build resilience considerations into City planning and capital projects, especially near the San Francisco Bay shoreline.

- Prioritize the Municipal Service Center (MSC), which is located in a potential future inundation zone, to determine the best approach to protect the emergency response capabilities and other services that the MSC provides.
- Pursue "green infrastructure" as required by the Regional Water Quality Control Board and as warranted by staff analysis; include supporting policies in the Comp Plan Update aimed at increasing storm water capture and infiltration.
- Evaluate and strengthen SLR and flooding concerns in planning, zoning, permitting and insurance requirements

REGENERATION AND THE NATURAL ENVIRONMENT

Sustainability is not only about mitigation and resiliency to change, but also about regeneration and identifying opportunities for renewal, restoration and growth of our natural resources and environment. Green infrastructure management provides one of the rare opportunities to enhance ecosystem positives such as sequestration of carbon, recharge of groundwater reserves, local food, walk-ability and bike-ability, and improved human health rather than solely reduction of negative impacts such as pollution and waste.

Palo Alto will continue to build the natural resources, "common wealth" and biocapacity that sustains it: soils, vegetation, tree canopy, biodiversity, water and many other critical components. Green infrastructure refers to natural areas and systems to provide habitat, flood protection, storm water management, cleaner air and cleaner water.

Goal: Renew, restoration and enhance resilience of our natural environment

Strategy: Adapt canopy, parklands, biodiversity, soil health to changing climatic regimes

- Implement the Urban Forest Master Plan
    - *Analyze and estimate potential tree canopy impacts due to changes in water application*
    - *Work closely with Utilities Department to evaluate current information, education programs and incentives to determine the most appropriate best practices for both urban forestry and water conservation goals.*
    - *Continue to develop and distribute information about preferred and restricted tree species, adapting trees to lower water needs, building greater drought resilience into tree planting sites through soil enhancements and selecting native or site appropriate trees of the proper size and characteristics.*
    - *Further explore and emphasize the importance of local foods, including smaller, fruiting trees and concepts related to local "food forests" that foster low-maintenance sustainable plant-based food production.*

- Develop and implement the Parks, Trails, Open Space & Recreation Master Plan
    - *Provide clear guidance and recommendations on how to meet the demands for future recreational, programming, environmental, and maintenance needs, as well as establish priorities for future park renovations and facility improvements.*
    - *Identify opportunities to increase sustainable and resource-saving practices associated the operation and management of parks and open space, as well as recreational facilities within the City.*

Strategy: Value and enhance the common wealth for future generations.

- Action 1. Prepare an audit of the commonwealth and common health under that government's jurisdiction.
    - *This audit would provide an inventory of parks, water and air quality, and infrastructure necessary for community wellbeing—all of the commons that are essential for the health and well-being of present and future generations. The audit could be reported as a qualitative, non-monetized set of assets.*
- Action 2. Draft a legacy plan for the commons.
    - *What is needed to improve, restore, and expand the commons to leave them in good shape for future generations? Some threats are particularly important to consider in plans. It is difficult to flourish in the face of floods, drought and fire. The legacy plan could become the basis of governmental sustainability goals.*
- Action 3. Review all regulations and land use plans for their impact on future generations.
    - *Designate a "guardian of future generations" empowered to recommend modifications to regulations and land uses that would protect future generations.*
    - *Evaluate incorporation of "ecosystem functionality" layers into planning GIS to ensure no diminution of ecosystem functionality by development processes*

Strategy: Deploy Green Infrastructure.

- Develop a green infrastructure policy
    - Require consideration of green infrastructure strategies whenever street or open space improvements may be made, including construction, landscaping and traffic calming projects.
    - Coordinate strategies across departments to leverage benefits. For example, reduced roadway and parking demand resulting from SOV-reducing transportation strategies would enable more permeable surfaces and water capture; Include such economic benefits in analysis of those transportation projects.
- Map city water flows and soil types to evaluate which types of green infrastructure investments and locations could provide greatest benefits
- Incent Green Roof Installation. Address through building policy or utility incentive the promotion of green roofs.
- Establish City policy on Green Streets and Green Parking Design.
    - Include Green Streets, alleys and curb cuts in street work, parking strips, planter areas of sidewalks, curb extensions, and street medians.
    - Establish City design policies to include green parking infrastructure in all new parking facilities
    - Incorporate additional green infrastructure elements into parking lot designs including permeable pavements installed in sections of a lot and rain gardens and bioswales included in medians and along a parking lot perimeter.

FINANCING, FUNDING AND INVESTMENTS

The total financial impact of the goals and strategies identified in this plan is estimated to result in a net present value of $400 million generated by estimated City investments of $10 million combined with investments across the Palo Alto economy of approximately $760 million over the next 14 years. (These are best estimates in the face of rapidly evolving technologies and rapidly improving price/performance ratios in energy, mobility and other sectors; they should be revised regularly.)

This return on investment may seem surprising that reducing GHG emissions are estimated to provide a net positive economic benefit, since most people have long thought that environmental quality costs money. But efficiency has long delivered good return on investment, and renewable energy is becoming increasingly competitive compared to fossil fuels. This makes carbon neutrality a good investment seen in the light of alternative costs if Palo Alto were to continue to source its energy from fossil fuels. Additionally, the levers and strategies identified in this plan also contribute to improving the health and quality of life for Palo Alto residents and businesses by reducing congestion, noise and local pollution.

Financing these pathways

Staff has identified a variety of potential sources of funds to finance the S/CAP; all of these sources (including private financial vehicles) need a more complete assessment of applicable legal and regulatory requirements and the risks and obligations associated with the various approaches.[20] These include operating savings, parking feebates, utility rates, revolving loan funds, local offsets, carbon tax or fee, voluntary contributions, green bonds, transfer taxes, public/private partnerships and private financial vehicles.[21] There is evidence that market demand exceeds supply for well-constructed sustainability and climate related investment opportunities; as a result some initiatives discussed here may be financeable through private investors.

Capital formation

People—and companies—sometimes resist environmental improvements for fear they are too expensive, or say we'll do as much as we can afford. But as the late Ray Anderson, founder and CEO of Interface, would say, "If you think sustainability is expensive, you're doing it wrong."

Analysis shows that sustainability can be a good investment. But it is an investment—and like any other can be structured in many ways

Many funding options are available and new forms are continually emerging. In most cases, innovation comes from combining instruments in creative ways to achieve specific goals rather than creating entirely new mechanisms.

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[20] The City of Palo Alto has just been award an $85k grant from USDN for a multi-city exploration of potential sustainability financing strategies

[21] This despite a common misperception: Most people who have not been deeply engaged in sustainability work assume that low-carbon and other sustainability initiatives will necessarily require financial, performance or quality of life sacrifices, because "better usually costs more." As we've seen in the world's product innovation, green building, and corporate eco-efficiency, this is not necessarily the case; in fact a growing body of evidence documents that attractive returns on investment are possible from well-designed and well-executed sustainability initiatives.

The “best” choice of funding vehicle for a particular entity is one that compliments the current political and cultural context of a region by allocating costs and benefits equitably. Figure 18 summarizes key financing options and their estimated scale.

Figure 19: Potential Financing Sources and Amounts

STRATEGIES	DESCRIPTION	POTENTIAL FUNDS	COMMENTS
Utility Costs Operating Savings	Allocate 50% of cost savings from retrofit of City buildings	$0.6m/yr	Current spend ~$6m/year; estimated 10% savings
Parking Feebates	Phase out free parking; apply revenues to commute alternatives as MaaS*	$10-20m/yr	(Modeled on the Stanford engine)
Utility Reserve	Apply 10% of Utility Reserve to finance low-carbon initiatives	$5m/yr	
Revolving Loan Fund	Establish bond-funded low-interest revolving loan fund for on-bill financing of efficiency projects	TBD	
Green Bonds	Issue green bonds to finance green infrastructure and low carbon initiatives	TBD	Beneficial interest rates since demand exceeds supply
Local Offsets	Switch GreenGas to opt-out; use portion of funds to finance qualified local projects (5% first year)	$1.6m/year	
Carbon Tax	Explore and pilot local carbon tax or fee	$5-15m/yr	See Boulder, for example. Would likely require ballot measure.
Total		$22.2-32.2m/yr	

Goal: Utilize diverse financial pathways to drive S/CAP implementation

- Evaluate the economic and legal feasibility of the financing measures identified in Figures ___
- Utilize the general fund to incentivize investments to promote appliance switching, which may not be possible for the Enterprise funds to finance due to legal restrictions.
- Establish internal carbon pricing for all City departments and financial activities.
- To the extent feasible, include carbon pricing into the gas rates to fund efficiencies and fuel switching.
- Identify a neighborhood or commercial district as a special district to carry out innovative pilot projects around GHG reduction, electric transportation development, or other approaches.

IMPLEMENTATION: TURNING VISION INTO ACTION

Achieving the emissions reductions detailed in this plan requires that the strategies and actions are implemented in a timely, coordinated a sustained way. Partial or poorly coordinated implementation will reduce the emissions reduction potential of the S/CAP.

Monitoring and Tracking Progress

The Office of Sustainability will be responsible for monitoring and reporting on the progress of the S/CAP on the following schedule:

- Community greenhouse gas inventory: Annually.
- S/CAP Strategy Indicators: Annually

Below, we summarize the key performance indicators associated with each Strategy:

Table 1. Summary of S/CAP Strategy Indicators for Monitoring Progress

Levers	Goals	Strategy	2030 Performance Target	2030 GHG Emissions Reduction (MTCO2e)
Rethinking Mobility	Expand non-auto mobility options	T-FAC-1. Expand bicycle infrastructure	Increase bike boulevard miles to 26 miles Increase in bike mode share to 30%	8,400
		T-FAC-2. Expand transit options	Increase transit ridership by 60%	19,200
		T-FAC-3. Grow ridesharing services	Increase in rideshare mode	6,400
	Create right financial incentives	T-INC-1. Provide universal transit passes	75% of residents and employees have universal transit passes	7,600
		T-INC-2. Implement parking pricing	50% of sites have parking pricing	18,400
	Implement land use approaches	T-LU-1. Increase zero-impact housing	Target 3.1 jobs-housing ratio	2,900
	Reduce carbon intensity of vehicles	T-EV-1. Electrify Palo Alto-based vehicles	90% of vehicles based in Palo Alto are zero emission	25,200
		T-EV-2. Electrify inbound vehicles	50% of inbound (not based in Palo Alto) vehicles are zero emission	29,800
Electrifying our City	Reduce use in existing businesses	NG-COMM-1. Electrify water heating in businesses	85% of commercial water heating is electric	21,200
		NG-COMM-2. Electrify space heating in businesses	85% of commercial space heating is electric	15,900
		NG-COOK-1. Electrify commercial cooking	50% of commercial cooking is electric	11,300
	Reduce use in	NG-RES-1. Electrify residential	Close to 100% of water heaters are	

	existing homes	water heating	electric	13,600
		NG-RES-2. Electrify residential space heating	70% of residential space heating is electric	23,300
	Reduce use in new buildings	NG-GAS-1. Encourage all-electric new buildings	New buildings are zero net energy ahead of state targets	11,900
Zero Waste	Enhance programs and infrastructure	SW-1. Achieve zero waste	Achieve 95% diversion rate	9,500

CONCLUSION

Climate change is a global problem and only through local solutions designed to meet the needs of our community can we mitigate and adapt to its impacts and protect the environment. While the challenge of climate change is unprecedented, local-level solutions can reduce emissions, increase efficiency, promote economic development, and improve quality of life for residents.

Together, we can continue to foster a vibrant economy, increase our resiliency and support Palo Alto's vision for a livable and sustainable community for generations to come. The City of Palo Alto has taken a significant step toward a more sustainable future with this climate action plan. This Plan has identified areas and opportunities to reduce GHG emissions within the community and City operations that along with statewide efforts can achieve our environmental goals.

While an important first step, this plan will remain a living document, to be updated as technology and policies progress, to support the City's efforts to manage GHG emissions for a sustainable future for all.

GLOSSARY

BAU: Business as Usual. Measures, initiatives or impacts that do not depend on new City of Palo Alto action

BAU 1: BAU resulting from demographic projections, external (State and Federal) policy choices. Based on CompPlan analysis, modified by S/CAP consultants to distinguish certain elements. (See BAU2)

BAU 2: BAU resulting from existing (enacted and/or in progress)

Palo Alto: The entire Palo Alto community, including COPA, residents and businesses

CPAU: City of Palo Alto Utilities

COPA or The City: City of Palo Alto municipal government, including City of Palo Alto Utilities

GHG: Greenhouse gas emissions

Palo Alto Sustainability and Climate Action Plan

Appendices: A Roadmap to 80 x 30

Draft – April 2016

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APPENDIX A: Palo Alto Greenhouse Gas Emissions Inventory

Palo Alto Community & City Municipal Operations GHG Emissions: Reduction of 36% since 1990

City Municipal Operations* & Palo Alto Community GHG Emissions Summary

Excludes Biogenic Emissions**; All units in Metric Tons (MT) of CO2 equivalent

	2005		2012		2013		2014		2015		
	Consumption Quantity	Emissions (MT of CO2e)	Consumption Quantity	Emissions (MT of CO2e)	Consumption Quantity	Emissions (MT of CO2e)	Consumption Quantity	Emissions (MT of CO2e)	Consumption Quantity	Emissions (MT of CO2e)	Notes
Scope 1 Emissions											
Natural Gas Use (Therms)	31,374,970	166,350	30,086,536	159,519	30,336,076	160,842	26,103,713	138,402	25,491,698	135,153	1
Natural Gas Distribution Leakage		4,718		4,718		4,718		4,781		4,781	2
Palo Alto Landfill Fugitive Emissions		6,811		4,336		6,640		8,470		8,617	3
Palo Alto Landfill Gas Flaring (biogenic)		5,853		3,827						5,941	3
Wastewater Process Emissions		8,504		6,414		5,024		4,616		4,080	*4*
Scope 2 Emissions -- Actual											
Total Electric Load (MWh)	996,091		966,839		986,241		978,561		965,857		
Hydro Supply (MWh)	548,760		413,584		406,570		266,026		251,466		
Renewables Supply (MWh)	49,980		188,566		188,086		172,139		227,110		
Brown Power Supply (MWh)	397,352	158,427	364,689	145,404	391,585	0	540,370	0	487,280	0	*5a*
Palo Alto Green Purchases (MWh)	30,601	(12,201)	75,805	(30,224)		N/A		N/A		N/A	*6*
Scope 2 Emissions -- Weather Adjusted* **											
Total Electric Load	996,091		966,839		986,241		978,561		965,857		
Hydro Supply (MWh)	514,073		514,073		514,073		514,073		514,073		
Renewables Supply (MWh)	49,980		188,566		188,086		172,139		227,110		
Brown Power Supply (MWh)	432,038	172,257	264,200	105,339	284,082	113,266	292,324	116,552	224,673	89,579	*5b*
Palo Alto Green Purchases (MWh)	30,601	(12,201)	75,805	(30,224)	0	0	0	0	0	0	*6*
Scope 3 Emissions											
Commute into, from, and within City		371,870		319,720		319,720		329,296		329,296	*7*
Lifecycle Emissions From Annual Total Waste Placed in Landfills	22,265	7,953	14,082	5,030	14,549	5,197	15,087	5,389	14,012	5,005	*8*
Landfilling Recyclable Material		22,779		14,406		14,886		15,435		14,335	*8*
Total Emissions (weather adjusted, biogenic excluded)		**752,130**		**591,373**		**515,497**		**507,346**		501,267	
			Emission Reduction (since 2005)	**21%**	**Emission Reduction (since 2005)**	**31%**	**Emission Reduction (since 2005)**	**33%**	**Emission Reduction (since 2005)**	**33%**	

Emission Reduction (since 1990)	**24%**	**Emission Reduction (since 1990)**	**34%**	**Emission Reduction (since 1990)**	**35%**	**Emission Reduction (since 1990)**	***36%***

Notes

1	*Total Community supply of natural gas use/delivery.*
2	*Leakage from the natural gas distribution system- modeled result, unchanged over the period.*
3	*Calculated using total captured landfill gas, actual methane percentage; fugitive gas assumed to be 33% of captured rate. 2005 estimate has been revised to reflect current methodologies.*
4	*Represents N2O emissions from biological treatment process and release of Nitrogen.*
5	*a. Represents actual quantity of brown power related emission @879 lbs/MWh in 2005 and 2012; not applicable beyond 2012 due to Carbon Neutral electric supply.* *b. Weather normalized (for hydroelectric generation) quantity of brown power. No GHG impact in 2015.*
6	*Emissions saved due to purchase of PaloAltoGreen related RECs. PAG related RECs not included in 2015 due to Carbon Neutral electric supply.*
7	*Study results from Fehr and Peer (03/19/2013) using Valley Transportation Authority regional transportation model based Vehicular Miles Travelled (VMT) and vehicular profiles - does not account for Palo Alto specific parameters related to greater penetration of alternate fuel vehicles, bicycle use, etc. Study results under review. 2015 assumed to be same as 2012.*
8	*Based on characteristics and tons of material landfilled: 2005, 2011, 2012 and 2013 figures; Landfilled amount in 2014 up 4% compared to 2012.*
*****	*Municipal emissions related to electricity and natural gas consumption included within utility load numbers; fleet vehicle emissions also assumed to be included in community wide commute related emissions estimates made by consultant.*
******	*Table excludes biogenic emissions related to: Landfill gas flaring and WQCP sludge incineration.*
*******	*Normalized to account for the vagaries of weather on hydroelectric supplies. No GHG impact in 2013.*

APPENDIX B – S/CAP Process

The S/CAP process investigated three scenarios (with different goals: 80x50, 80x30, 100x25) in considerable detail. For each, the S/CAP team asked: "what combination of strategies and measures might make it possible to meet that specific goal?"

The list of potential measures was fairly clear; their feasibility, and pace of introduction, was not. So the team then filtered for technical feasibility; cost effectiveness (over time, since costs for many relevant technologies has been dropping rapidly); mitigation cost (which may make some measures attractive even if not strictly speaking cost effective, and worth exploring through alternative financing strategies). The team considered likely timing, and the entry points afforded by technology life cycles. For existing buildings, the team considered leverage points for change: pulling a permit, appliance failure (actual or predicted), time of sale. The team assumed starting with voluntary programs (like CPAU's Heat Pump Water Heater pilot), and potentially adding mandatory programs (such as the proposed Energy Reach Code proposed by Development Services) as the team understands better what's possible and what's needed. And the team applied informed and wherever possible documented assumptions about costs, availability, rate of adoption, etc. (Where documented data was not available—for example with new initiatives like Mobility as a Service—the assumptions are intentionally conservative, and probably underestimate GHG reduction potential.)

The S/CAP team benefited from expert opinion from Rocky Mountain Institute, as well as experts from Stanford University, Goldman Sachs, Carbon Free Palo Alto, the Urban Sustainability Directors Network, and other advisors. Community engagement included: a design charrette (40 people), an ideas expo (80 people), two polling cycles (~500 people), a community climate summit (300 people), several study sessions with Council, UAC and CAC, regular meetings with staff through the Sustainability Board and several staff retreats, the S/CAP Advisory Board (27 people), community meetings, newsletters (2500 people), social media (600 people) and individual conversations. Staff will continue to seek community input as the Draft S/CAP provides specific proposals and analysis for consideration by the City Council and the community.

APPENDIX C – S/CAP Strategy Calculation and Assumptions

In this section, we describe the key assumptions associated with each S/CAP strategy to estimate GHG reduction potential for the 80% below 1990 levels by 2030 target.

T-FAC-1	o Percent of proposed bicycle lanes added annually from 2016 to 2030: 6.67% (DNV GL) o Trips per Capital Bikeshare station per month: 1,000 trips/month (https://www.capitalbikeshare.com/) o Estimated percent of Palo Alto land area suitable for bikesharing: 40% (DNV GL) o Total bikesharing stations in Palo Alto by 2030 at 28 stations/square mile density: 266 stations in Palo Alto (https://www.capitalbikeshare.com/) o BAU annual bicycle trips to/from/within Palo Alto: 25,099 trips (Palo Alto Bicycle and Pedestrian Plan projection for 2035. 2035 projection used for 2030, assuming early implementation of planned facilities and services.) o Percent increase in daily bike trips compared to 2030 BAU resulting from establishment of enhanced bicycle facilities: 100% increase (DNV GL) o Each 1% shift of driving trips to bicycle trips reduces VMT by 0.5% (Carbon Neutral Scenario Analysis + Pudget Sound Regional Council 2006 Household Activity Survey Analysis Report) o Total miles of additional bicycle lanes built by 2030 under proposed "40% of full implementation scenario": 21 miles (DNV GL) o Percentage of additional arterial bicycle lanes that will require arterial motorized vehicle lane reduction: 50% (DNV GL) o Percent of average daily motor vehicle traffic eliminated by lane reduction: 22% (http://contextsensitivesolutions.org/content/reading/disappearing-traffic/resources/disappearing-traffic/)
T-FAC-2	o Annual percentage increase in all public transportation ridership: 6.67% (DNV GL) o Total percent increase in VTA El Camino BRT, SamTrans, and Palo Alto Shuttle average weekday ridership from 2014 to 2030: 60% ridership increase (DNV GL) o California High Speed Rail Palo Alto boardings per day by 2030: 7,800 boardings (http://www.paloaltoonline.com/news/2010/09/21/stanford-resists-local-high-speed-rail-station) o Express bus service in dedicated bus lanes with 90 second headways on US 101 throughout the peak hour by 2030 (DNV GL)
T-FAC-3	o Informal/casual carpooling programs started in the US 1010 corridor • Ridership to/from Palo Alto is proportionate to Pal Alto's share of all boardings/alightings in Caltrain Corridor – 14.4%. (Caltrain) • Web/assisted/dynamic ridematching options allowing shared travel to multiple destinations – opposed to "many to one" model of casual carpooling in East Bay/SF market (DNV GL) • Would facilitate shared travel to major employment site through the 101 corridor: San Francisco, San Jose + site in between (DNV GL) • Analysis assumes that the travel market for the full 101 corridor would be approximately twice the volume of shared rides in the East Bay/SF market during both AM + PM peak periods. This is due to the bi-directional nature of travel in the region opposed to primarily in-bound trips in East Bay/SF

	market (DNV GL) o Estimated volume of casual carpoolers/dynamic ridesharers in 101-corridor by 2030: (Berolo (1990)[est. 8,000], and Litman (2004) [est. 10,000]) • Northbound AM: 9,000 • Soutbound AM: 9,000 • Northbound PM: 9,000 • Southbound PM: 9,000 o Percent of 101-corridor daily carpool/rideshare trips to/from Palo Alto beyond BAU by 2030: 19.4% This assumption is based on Palo Alto's share of Caltrain boardings/alightings -14.4% - plus a adjustment factor – plus 5% - to account for the above average participation rate at Stanford University. (Caltrain + DNV GL)
T-INC-1	o Annual percent ramp-up of program from 2016 to 2030 (reaching 100% deployment of program in 2030): 7% annual increase (DNV GL) o Percent of Palo Alto resident work trips via public transportation in 2014: 5.0% (2014 Dev. CAP) • Percent change in transit ridership for resident work trips from 2014 to 2030 above BAU increase: 82.9% (Santa Clara VTA, Bellevue, WA, Boulder, CO, Ann Arbor, MI) o Percent of Palo Alto resident non-work trips via public transportation in 2030 BAU: 4.1% (Valley Transportation Plan 2035, Santa Clara VTA). • Percent change in transit ridership for resident non-work trips with Eco-Pass implementation: 79.0% (Caltrans: "Parking and TOD: Challenges and Opportunities," 2002) o Housing units in Palo Alto in 2010: 28,546 households (Comp Plan EIR) • Percentage of housing units in multi-unit buildings in 2010: 38.5% (US Census 2010) o Housing units in Palo Alto by 2030: 32,964 (Placeworks, Scenario 4) • Percentage of units in multi-unit buildings in 2030: 42.5% (DNV GL)
T-INC-2	o Annual ramp up of program from 2016 to 2030 (reaching 50% of full implementation by 2030): 3.3% (DNV GL) o Percent of total floor space – both commercial and residential – affected by off-street parking reforms by 2030 under 100% implementation scenario: 32% (Nelson, A. 2006, JAPA) o Percent reduction in residential vehicle VMT (non-work and non-commercial/heavy truck travel) at sites affected by off-street parking reforms: 20% (DNV GL) o Percent reduction in work-related auto trip to Palo Alto from adoption of employee parking pricing under 100% implementation scenario: 27.4% (Mid Wilshire/LA, Warner, Century City, Civic Center, Ottawa). • Projected BAU drive-alone mode share for work trips in 2030: 73.9% (VTA VTP 2035)
T-EV-1	o Annual percent increase in electric vehicles owned by Palo Alto residents beyond the BAU increase in electric vehicle ownership from 2016 to 2030: 6% (DNV GL) o Percent of total vehicles owned by Palo Alto residents that are electric vehicles by 2030 under BAU scenario: 25.5% (CPAU + Committee on Transitions to Alternative Vehicles and Fuels "Transitions to Alternative Vehicles and Fuels", 2013) o Percent of total vehicles owned by Palo Alto residents that are electric vehicles by 2030 under policy scenario: 92.5% (DNV GL) o Annual percent increase in non-electric vehicle MPG and electric vehicle MPG-equivalent from 2016 to 2030 (http://www.epa.gov/otaq/fetrends.htm). o Percent increase in BAU VMT of Palo Alto residents from 2016 to 2030: 11%

	(DNV GL)
T-EV-2	o Annual percent increase in electric in share of vehicles not owned by Palo Alto residents (responsible for external-internal VMT) that are electric vehicles by 2030: 4% (DNV GL) o Percent of vehicles not owned by Palo Alto residents (responsible for external-internal VMT) that are electric vehicles by 2030: 60% (DNV GL)
T-LU-1	o Assume jobs/employed resident ratio of 2.95, resulting in increase of 5,600 housing units by 2030, compared with CompPlan 2030 BAU estimates of an increase of 2,719 housing units by 2030. o Assume 30% average reduction in VMT per capita associated with compact development relative to sprawl-type development (Ewing, p.33) o Assume additional housing units to be "compact development" in mixed-use development or "infill" backyard cottages within existing urban street grid of Palo Alto
NG-RES-1	o Life of typical gas water heater: 13 years (CPAU) o Percent reduction in residential water heating demand from EE measures: 10% (DNV GL) o One residential water heater per home in Palo Alto (estimate) o 5% of residential water heaters replaced each year from 2016→2030
NG-RES-2	o Life of typical gas furnace: 20 years (CPAU) o One gas furnace per home in Palo Alto (DNV GL) o Percent reduction in space heating demand from EE measures: 10% (DNV GL) o Life of air source heat pump: 20 years (CPAU) o 4% of furnaces replaced each year from 2016→2030
NG-COMM-1	o Overall Palo Alto Commercial Assumptions: • Total commercial square footage in Palo Alto: 28,300,000 square feet (Palo Alto Comprehensive Plan - http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) • Life of typical gas water heater: 13 years (CPAU) • 3% of commercial gas water heaters replaced each year from 2016→2030 • Percent reduction in commercial water heating demand from EE measures: 10% (DNV GL) o Palo Alto "Small Commercial" Assumptions: • Total square footage of "Small Commercial" requiring residential-style heat pump hot water in Palo Alto: 26,602,000 square feet (Palo Alto Comprehensive Plan - http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) • One heat pump hot water heater per small office or restaurant • Life of heat pump electric water heater: 13 years (CPAU) o Palo Alto Large Commercial Assumptions • Total square footage of "Large Commercial" requiring solar thermal with 60% solar fraction coupled with electric resistance heating hot water in Palo Alto: 1,698,000 square feet (Palo Alto Comprehensive Plan - http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) • Solar fraction for domestic hot water energy use: 60% (DNV GL) o Life of solar-electric heat pump hot water system: 15 years (DNV GL)
NG-COMM-2	o Overall Palo Alto Commercial Assumptions • Percent reduction in commercial space heating demand from EE measures: 10% (DNV GL) • Total commercial square footage in Palo Alto: 28,300,000 square feet (Palo Alto Comprehensive Plan -

	http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) o Palo Alto Small Commercial Assumptions • Life of typical gas-pack furnace: 10 years (CPAU) • Total square footage of "Small Commercial" requiring in-kind replacement of gas-fired package units with heat pump packaged units for space heating in Palo Alto: 26,602,000 square feet (Palo Alto Comprehensive Plan - http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) • Life of heat pump space heater: 10 years (CPAU) o Palo Alto Large Commercial Assumptions • Life of standard furnace boiler: 15 years (CPAU) • Total square footage of "Large Commercial" requiring replacement of chiller and boiler with heat recovery chiller feeding heating hot water loop for space hating: 4,245,000 square feet (Palo Alto Comprehensive Plan - http://www.cityofpaloalto.org/civicax/filebank/documents/8170 + Loopnet) • Typical life of heat recovery chiller: 15 years (DNV GL)
NG-COOK-1	o 3% of eligible restaurant kitchens converted from gas to electricity per year from 2016→2030 o Total restaurants with fume hood in Palo Alto: 169 (Melissa Data, ZipMap, Yelp) o Percent of restaurants in Palo Alto with fume hood using natural gas for cooking: 50% (DNV GL) o Median square footage of restaurants in Palo Alto: 3,500 square feet (http://www.restaurantowner.com/public/1317.cfm) o Typical life of gas and electric kitchen equipment: 12 years (http://www.fishnick.com/saveenergy/tools/calculators)
NG-GAS-1	o 3% annual increase in BAU efficiency of new commercial and residential construction due to building codes (DNV GL) o New commercial square footage per year from 2016→2030: 327,848 square feet/year (Placeworks Scenario 4) o New residential housing units per year from 2016→2030: 316 housing units (Placeworks Scenario 4) o 2014 Housing units in Palo Alto: 28,546 housing units (Placeworks Scenario Analysis)
SW-1	o Community-wide waste diversion rate in 2014: 78% (Palo Alto Earth Day Report) • BAU waste diversion rate remains at 78% from 2014-2013 o Waste diversion rate by 2030: 92% (DNV GL) • Annual percent increase in waste diversion rate: 0.93% (DNV GL) o Annual increase in community-wide total generated waste (including landfill, recycling, compost): 1.46% (projections based on historic data from Palo Alto Earth Day Report) o Waste emissions factors: • Life cycle emissions per ton of waste placed in landfills: 0.36 MT CO2e/Ton (Palo Alto Earth Day Report) • Emissions resulting from recyclable materials per ton of waste placed in landfills: 0.79 MT CO2e/Ton (Palo Alto Earth Day Report).

APPENDIX D – Analysis of Three Possible Emissions Scenarios

When it comes to issues as complex and uncertain as climate change, scenario development is a valuable tool for stimulating debate, stretching the imagination, and inspiring action and innovation. To support this, the S/CAP project previously developed emissions reduction scenarios to help define the limits of what can be done locally (by the community and the local government), including some actions to be taken regionally (by the agencies and communities with which the City interacts) to achieve deep reductions in GHG emissions. The scenarios explore the limits of what Palo Alto, as a progressive city and an engine of innovation and global economic growth, can do to achieve deep reductions in GHG emissions. What does success look like, and how can the City help create conditions for that success?

In contrast to most City initiatives, the S/CAP project approach is to explicitly link the City's more traditional approach toward safely achievable goals with a "reverse engineered" future vision—planning backwards from "impossible" goals to the present—and ensuring that those two approaches meet.

Staff and consultants explored three "goals scenarios":

- California's goal of 80% reduction of GHG emissions by 2050 (80x50);
- a more aggressive goal of 80% reduction by 2030 (80x30)[1]; and
- the "California Moonshot": 100% carbon neutral by 2025 (100x25).

At the beginning of the SCP process, we didn't know whether the Moonshot—or any of these goals—is achievable either financially, politically or socially. But we did know that the challenges we pose affect the questions we ask, and the questions we ask affect the answers we find. By first assessing extremely aggressive goals, we have uncovered potential strategies that we would not have found – or even looked for – if were focusing on an 80% reduction in GHG emissions by 2050. As a result we have uncovering the potential strategies, driven by the "moonshot" challenge, that we would not have found—or even looked for—if we were focusing on 80x50.

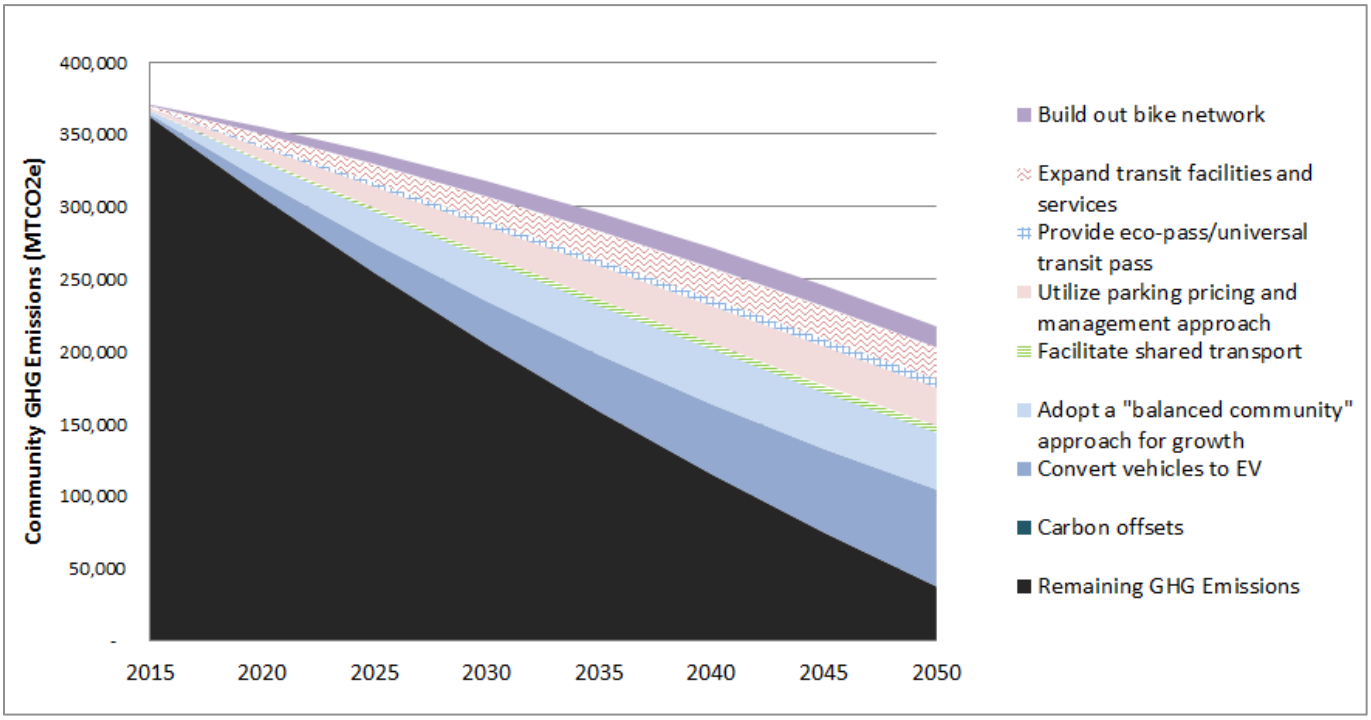
Below, we summarize the results of the scenario analysis utilized to inform the development of the S/CAP and support a grounded conversation by Council and community about those goals, by providing clear roadmaps of what it would take to reach each of them.

[1] Note that on April 29, 2015, Governor Jerry Brown issued an executive order to establish a California greenhouse gas reduction target of 40 percent below 1990 levels by 2030. Governor Jerry Brown has also called for 50 percent of California's electricity to come from renewable resources by 2030, doubling energy efficiency of existing buildings and reducing automobile dependency on oil and gas by 50 percent.

2050 Executive Order: 80% reduction by 2050 (80x50)

In the transportation sector, full implementation of the strategies explored would result in Palo Alto achieving carbon neutrality by 2050. The top of the stacked areas represents the business-as-usual projections based on historic vehicle fuel efficiency improvements from 2005-2012 which offsets the BAU forecasted increase in VMT. Each of the colored areas represents the emission reductions associated with different transportation strategies. The black area represents the remaining GHG emissions. With the 100% adoption of electric vehicles combined with reductions in vehicle-miles traveled, no carbon offsets are needed in this scenario.

Figure 1. Possible Transportation Sector Strategies to Achieve 2050 Target



Strategy Code	Transportation Strategy Name	Implementation Level by 2050	Implementation Description
T-FAC-1	Build out bike network	100%	Convert all class II bike lanes to protected bike lanes Increase bike boulevard mileage from 22-32 miles Expand bike share to 28 stations per square mile
T-FAC-2	Expand transit facilities and services	100%	Caltrain modernization ridership targeted in 2040 achieved Expand SamTrans, VTA and Palo Alto shuttles by 200% El Camino Real and Dumbarton Bus Rapid Transit
T-FAC-3	Facilitate shared transport	100%	Dynamic ridesharing based on San Francisco casual carpool rates, with Palo Alto share proportionate to Palo Alto Caltrain ridership
T-INC-1	Provide eco-pass/universal transit pass	100%	Expanded Universal Transit Pass (UTP) - Caltrain GoPass, SamTrans Way2GoPass, and VTA Ecopass, for all residents and employees

T-INC-2	Utilize parking pricing and management approach	100%	All employment sites institute parking pricing, parking cash-out, parking feebate equivalent to market price of parking Full cost pricing of residential parking (unbundling or eliminating minimum parking requirements)
T-LU-1	Adopt a "balanced community" approach for growth	100%	Assume jobs-housing balance of 1.44 with growth in specific areas (e.g., Stanford Research Park, downtown core, Stanford Shopping Center, etc)
T-EV-1	Convert vehicles to EV	100%	Assume all vehicles are electric, or zero emissions
T-PT-1	Carbon offsets	0%	No offsets needed

2050 Possible Transportation Roadmap

		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
Objective: Expand non-auto mobility options	T-FAC-1 Build out bike network for all ages and abilities	Expand bikesharing program by identifying next 10-15 sites, funding and coordination with future development		Build bike stations (parking/shower/locker facilities) near public transit hubs/key destinations /transfer points			Achieve 28 bike share stations per square mile (267 stations)					
			Identify Class II bike lanes for upgrade to protected bike lanes (also know as "cycle tracks") and integrate with bicycle boulevards		Achieve 45% of class II bike lanes converted to protected bike lanes				Achieve 100% of class II bike lanes converted to protected bike lanes			
	T-FAC-2 Expand transit facilities and services	Palo Alto TMA launched to support alternatives to driving	Continue to explore ways to expand service on local bus/shuttle routes related to SamTrans, VTA and Palo Alto shuttles. Assess needs and opportunities for increased service and ridership (links to provide eco-pass, universal transit pass)				Expand public transit ridership by 200% by 2050					
		Advocate for major upgrades to reliability, frequency, and capacity of Caltrain service. Assess potential for below grade Caltrain improvements			Work with Caltrain to implement major upgrades to reliability, frequency, and capacity of Caltrain service ahead of 2040 timeline							
		Build political support for bus rapid transit along El Camino Real and cross-town Dumbarton			Provide a dedicated bus lane and signal priority for El Camino Real Bus Rapid Transit.							
	T-FAC-3 Facilitate shared transport		Palo Alto TMA to assess opportunities to increase availability and utilization of vanpools		Provide incentives to expand availability and utilization of vanpools							
		Encourage third-party developers to explore data-driven transit solutions through competitions, hack-a-thons, etc		Implement cohesive data platform to support Mobility as a Service (MaaS)								
			Designate curb space for rideshare/carpool pick-up and drop-off downtown, and at Caltrain stations		Discount parking for carpools, paid parking refund for vehicles parked in public lots or on-street							

		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
Objective: Create right financial incentives for alternatives	T-INC-1 Provide eco-pass/universal transit pass	Require Caltrain go-pass as requirement for MF development	Expand requirements to include additional residential new construction and significant renovation projects within 0.5 miles of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					100% of Palo Alto residents have universal transit pass		
		Require Caltrain go-pass as requirement for large office developments	Expand requirements to include all employers within 0.5 mile of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					100% of Palo Alto employees have universal transit pass		
	T-INC-2 Utilize parking pricing and management approaches		Incentivize unbundling of parking costs from lease/sale of commercial/residential units			Require unbundling of parking costs from lease/sale of commercial/residential units				Eliminate requirements for provision of off-street parking for new commercial/residential		
		Incentivize employers to offer employees option to receive transportation benefits instead of parking benefits (feebates, etc)			Require employers to offer employees option to receive transportation benefits instead of parking benefits							
			Adopt on-street parking vacancy target	Use meters/permits/time limits to manage parking demand in congested areas, along with mobile apps								
			Monitor occupancy and availability of on-street parking regularly									

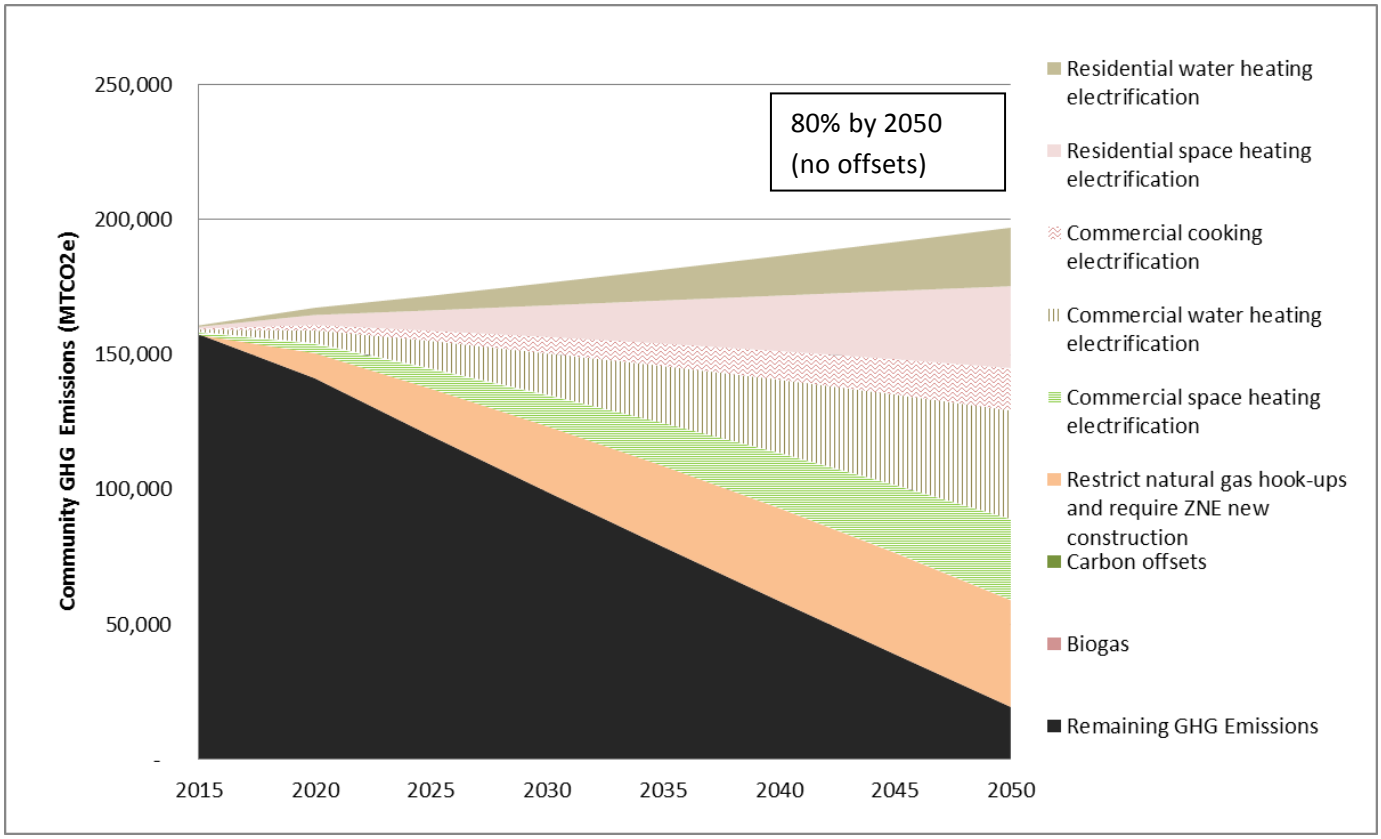
		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
Objective: Implement land-use development approaches	T-LU-1 Adopt Comp Plan Scenario 4 (Modified)	Replace zoning restrictions on residential unit density with a cap on average daily vehicle trips generated		Provide incentives for growth and development in transit-accessible areas (e.g., tying allowable floor-to-area ratios to reductions in VMT and other sustainability measures)								
		CompPlan 2030 underway	Through CompPlan 2030, continue to identify areas for increased density and potential future development		Enable/support low-traffic/low-carbon mixed-use development, in specific areas through zoning, complete streets requirements and other land use strategies							

		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
LEVER: Reduce carbon intensity of vehicular travel	T-EV-1 Convert vehicles in Palo Alto and surrounding region to EVs	Develop and implement EV charging infrastructure plan for city City fleet vehicles lead the way: electric school buses, garbage trucks, etc		Support and incentivize public & private EV charging infrastructure through reducing permitting fees/streamlining process	Sales tax refund for EV purchased in Palo Alto by Palo Alto residents					100% of vehicles are electric by 2050		
			Develop Priority parking program for EVs	Investigate options for community-scale bulk purchasing of EVs	Bulk purchase program for EV's and EVSE equipment to bring down costs of EV purchases							
		Require pre-wiring of electric vehicle charging infrastructure		Require electric vehicle supply equipment (EVSE) actually installed for all new residential / commercial construction, additions, and remodels								
			Incentivize automakers to design improved EVs through kickstarter campaign (similar to Automotive X Prize)									
		Engage with EV car dealerships to simplify sales process and promote EV educational resources		Collaborate with and promote EV charging apps (e.g. PlugShare)	Smart phone apps to provide real-time traffic information, and provide reservation services and map of available EV charging stations.							
		Develop behavior-change campaign(s) to encourage residents and employees to purchase EV's, utilize public charging stations.		Monitor purchases of EV's, installation of charging stations, to determine whether uptake is meeting targets. Adjust targets and behavior change campaigns accordingly.								

Similarly, Figure 1provides one possible roadmap to 80% reduction by 2050 for the natural gas sector. The top of the stacked colored areas represents the business-as-usual forecasted increase in natural gas consumption, with the colored wedges representing emissions reduction strategies. The black area at the bottom is the remaining GHG emissions. For the natural gas sector, this scenario assumes all new construction is all-electric and net zero energy, along with significantly more water heating and space heating electrification in the existing commercial building sector by 2050. In this scenario, no carbon

offsets are needed to achieve the 2050 target. The estimated net present value is $465 million associated with natural gas strategies in this scenario.

Figure 2. Possible Natural Gas Sector Strategies to Achieve 2050 Target



Strategy Code	Natural Gas Strategies	Implementation Level by 2050	Annual Adoption Rate	Implementation Description
NG-RES-1	Residential water heating electrification	100%	3%	Assume all residential water heaters could be replaced with electric if we start immediately
NG-RES-2	Residential space heating electrification	70%	2%	Residential space heating more difficult and less cost-effective than water heating
NG-COMM-1	Commercial water heating electrification	85%	2%	Assume small commercial buildings have a gas storage tank water heater that is replaced by an air source heat pump water heater. Assume large commercial buildings have a gas boiler that is replaced with solar hot water and electric resistance heating.
NG-COMM-2	Commercial space heating electrification	85%	2%	Assume small commercial buildings have gas-pack furnaces that are replaced by a packaged heat pump heater. Assume large commercial buildings have gas boilers that are replaced with heat recovery chillers.

NG-COOK-1	Commercial cooking electrification	50%	1%	Given the industry, fairly aggressive, but minimal impact on overall cost of scenario
NG-GAS-1	Restrict natural gas hook-ups and require ZNE new construction	100%	100%	All new construction achieves ZNE, no gas hook-up (both residential and commercial)
NG-OFF-1	Carbon offsets	0%	0.0%	No offsets needed to achieve 80% by 2050 goal
NG-OFF-2	Biogas	0%	0.0%	No biogas needed to achieve 80% by 2050 goal

2050 Possible Natural Gas Roadmap

		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
NG-RES-1 & NG-RES-2 Residential water heating / space heating - fuel switch	Replace on burnout pathway	Information services for electric water heaters/ space heating systems		Pilot 24-hour hotline	Full implementation of 24-hour hotline for electric water heater replacement			Require all water heaters / space heating systems be replaced with electric at end-of-life				
	Voluntary retrofit pathway	Develop utility program for electric water heater/space heating system replacements, pilot electrification of a sample of homes		Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed				Require electrification as part of all water heaters / space heating system retrofit projects				
	Institutional pathway	Streamline permitting process for electric water heaters / space heating systems		Work with local distributors and contractors to implement upstream incentive programs								
	Time of sale pathway	Develop energy benchmarking and disclosure time-of-sale ordinance for residential		Voluntary time-of sale ordinance for energy efficiency and electrification (incentives and recognition program)				Mandatory time-of-sale ordinance for energy efficiency and electrification				

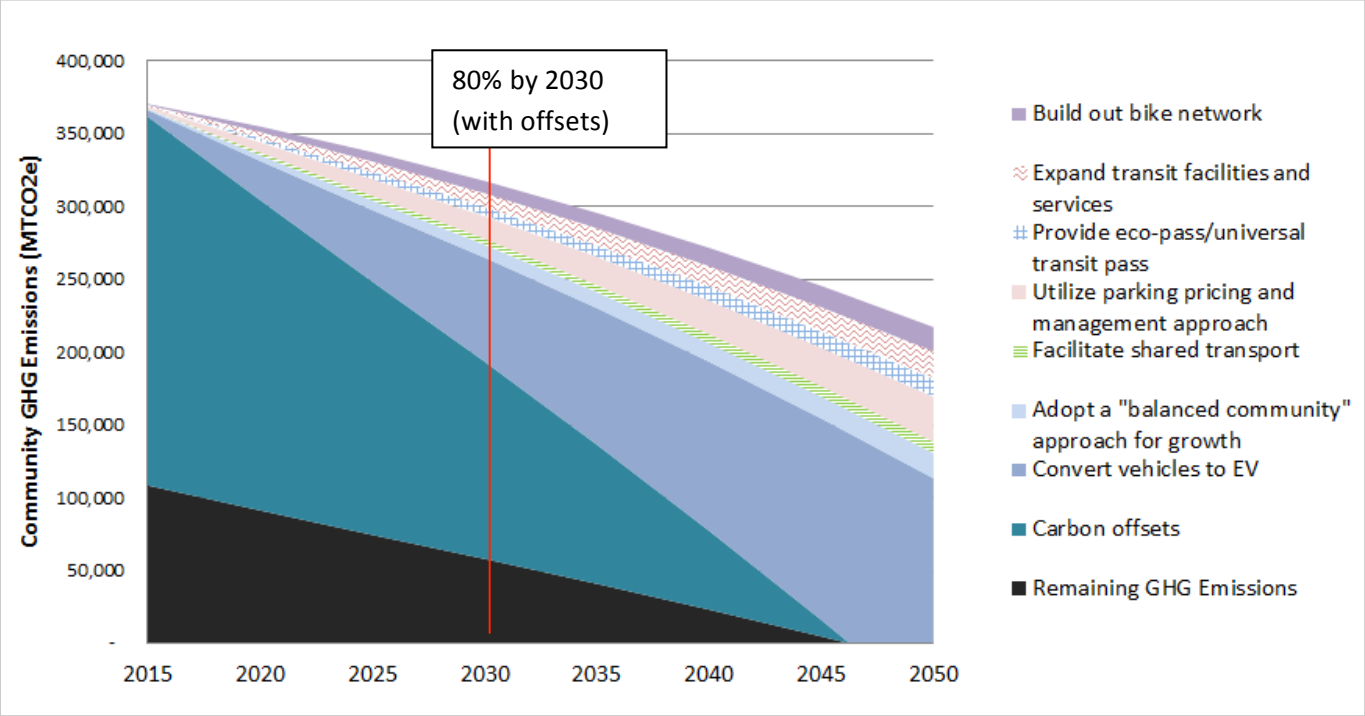
		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
NG-COMM-1 & NG-COMM-2 Commercial water heating / space heating - fuel switch	Tenant improvement pathway	Information and outreach related to tenant improvement building permits		Voluntary program (e.g., incentives, checklists, expedited permitting, reduced fees) for electrification of space and water heating equipment				Require electrification as part of all water heaters / space heating system retrofit projects				
	Voluntary retrofit pathway	Develop utility program for electric water heater/gas heating system replacements		Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed								
	Institutional pathway	Streamline permitting process for electric water heaters / space heating systems		Work with local distributors and contractors to implement upstream programs								
	Time of sale pathway	Education and outreach to vendors, landlords, real estate community		Develop voluntary time-of-sale requirement for energy upgrades				Develop mandatory time-of-sale requirement for energy upgrades				

		2015	2018	2020	2022	2024	2025	2030	2035	2040	2045	2050
N-OFF-1 and NG-INF-1 Green gas, offsets and new utility business model to support carbon neutrality	Green gas pathway	Implementation of voluntary "Palo Alto Green Gas" program	Assess costs of carbon offsets and biogas for all natural gas usage in the community	Purchase of carbon offsets and/or biogas with goal of 100% by 2020								
	Infrastructure pathway	implement study of natural gas distribution system and impacts of reduced natural gas consumption		Develop roadmap for staged/planned reductions in specific areas of the city (which neighborhoods are likely to be most impacted/early adopters)			Actively manage reductions in natural gas delivery					
	Financing and rates pathway	Assess appropriate restructuring of natural gas and electricity rates for electrification		Restructure natural gas & electricity rates to support fuel switching to electricity			Continue to support policy and long term planning for restructuring gas utility that will minimize financial risks to rate payers or bond-holders					

2030 Challenge: 80% reduction by 2030 (80x30)

Under this 80x30 scenario, additional carbon offsets are needed to achieve the 80% reduction by 2030 goal. For 2030, we considered what aggressive levels of implementation might be possible by 2030 for protected bike lanes, transportation network company facilitated ridesharing, universal transit pass, parking pricing (e.g., unbundling and full cost pricing of parking), etc. In this scenario, the selected strategies and associated implementation levels achieve the target; thus, and carbon offsets are not necessary to meet the 2030 target. The 2030 scenario is estimated to result in approximately $390 million in net present value (savings), along with an investment cost of approximately $800 million.

Figure 3. Possible Transportation Sector Strategies to Achieve 2030 Target



Strategy Code	Transportation Strategy Name	Implementation Level by 2030	Implementation Description
T-FAC-1	Build out bike network	40%	40% of class II bike lanes converted to protected bike lanes Increase bike boulevard mileage from 22-26 miles Expand bike share to 11 stations per square mile
T-FAC-2	Expand transit facilities and services	60%	Expand SamTrans, VTA and Palo Alto shuttle ridership by 60% and support bus rapid transit and advocate for major upgrades to reliability, frequency, and capacity of Caltrain service.
T-FAC-3	Facilitate shared transport	60%	Achieve 60% of current levels of SF casual carpool rates, pro-rated for Palo Alto
T-INC-1	Provide eco-pass/universal transit pass	100%	100% of residents and employees have Universal Transit Passes
T-INC-2	Utilize parking pricing and management approach	50%	All city parking sites and 50% of private sites have parking pricing
T-LU-1	Adopt a "balanced community" approach for growth	5%	Target 2.95 jobs-housing balance, as defined by jobs-employed residents ratio (currently at 3.06 in 2014)
T-EV-1	Convert Palo Alto vehicles to EV	90%	90% of vehicles converted to electric
T-PT-1	Carbon offsets	0%	No carbon offsets are needed to achieve the 80x30 GHG target

2030 Possible Transportation Roadmap

		2015	2016	2017	2018	2019	2021	2023	2025	2027	2029	2030
Objective: Expand non-auto mobility options	T-FAC-1 Build out bike network for all ages and abilities	Expand bikesharing program by identifying next 10-15 sites, funding and coordination with future development		Build bike stations (parking/shower/locker facilities) near public transit hubs/key destinations /transfer points			Achieve 11 bike share stations per square mile (81 stations)					
			Identify Class II bike lanes for upgrade to protected bike lanes (also know as "cycle tracks") and integrate with bicycle boulevards		Achieve 15% of class II bike lanes converted to protected bike lanes				Achieve 40% of class II bike lanes converted to protected bike lanes			
	T-FAC-2 Expand transit facilities and services	Palo Alto TMA launched to support alternatives to driving	Continue to explore ways to expand service on local bus/shuttle routes related to SamTrans, VTA and Palo Alto shuttles. Assess needs and opportunities for increased service and ridership (links to provide eco-pass, universal transit pass)				Expand public transit ridership by 60% by 2030					
		Advocate for major upgrades to reliability, frequency, and capacity of Caltrain service. Assess potential for below grade Caltrain improvements			Work with Caltrain to implement major upgrades to reliability, frequency, and capacity of Caltrain service ahead of 2040 timeline							
		Build political support for bus rapid transit along El Camino Real and cross-town Dumbarton			Provide a dedicated bus lane and signal priority for El Camino Real Bus Rapid Transit.							
	T-FAC-3 Facilitate shared transport		Palo Alto TMA to assess opportunities to increase availability and utilization of vanpools		Provide incentives to expand availability and utilization of vanpools							
		Encourage third-party developers to explore data-driven transit solutions through competitions, hack-a-thons, etc		Implement cohesive data platform to support Mobility as a Service (MaaS)								
			Designate curb space for rideshare/carpool pick-up and drop-off downtown, and at Caltrain stations		Discount parking for carpools, paid parking refund for vehicles parked in public lots or on-street							

		2015	2016	2017	2018	2019	2021	2023	2025	2027	2029	2030
Objective: Create right financial incentives for alternatives	T-INC-1 Provide eco-pass/universal transit pass	Require Caltrain go-pass as requirement for MF development	Expand requirements to include additional residential new construction and significant renovation projects within 0.5 miles of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					75% of Palo Alto residents have universal transit pass		
		Require Caltrain go-pass as requirement for large office developments	Expand requirements to include all employers within 0.5 mile of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					75% of Palo Alto employees have universal transit pass		
	T-INC-2 Utilize parking pricing and management approaches		Incentivize unbundling of parking costs from lease/sale of commercial/residential units			Require unbundling of parking costs from lease/sale of commercial/residential units				Eliminate requirements for provision of off-street parking for new commercial/residential		
		Incentivize employers to offer employees option to receive transportation benefits instead of parking benefits (feebates, etc)			Require employers to offer employees option to receive transportation benefits instead of parking benefits							
			Adopt on-street parking vacancy target	Use meters/permits/time limits to manage parking demand in congested areas, along with mobile apps								
			Monitor occupancy and availability of on-street parking regularly									

		2015	2016	2017	2018	2019	2021	2023	2025	2027	2029	2030
Objective: Implement land-use development approaches	T-LU-1 Adopt Comp Plan Scenario 4 (Modified)	Replace zoning restrictions on residential unit density with a cap on average daily vehicle trips generated		Provide incentives for growth and development in transit-accessible areas (e.g., tying allowable floor-to-area ratios to reductions in VMT and other sustainability measures)								
		CompPlan 2030 underway	Through CompPlan 2030, continue to identify areas for increased density and potential future development		Enable/support low-traffic/low-carbon mixed-use development, in specific areas through zoning, complete streets requirements and other land use strategies							

<table>
<tr><th></th><th></th><th colspan="2">2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2021</th><th>2023</th><th>2025</th><th>2027</th><th>2029</th><th>2030</th></tr>
<tr><td rowspan="6">LEVER: Reduce carbon intensity of vehicular travel</td><td rowspan="6">T-EV-1
Convert vehicles in Palo Alto and surrounding region to EVs</td><td colspan="2">Develop and implement EV charging infrastructure plan for city

City fleet vehicles lead the way: electric school buses, garbage trucks, etc</td><td>Support and incentivize public & private EV charging infrastructure through reducing permitting fees/streamlining process</td><td colspan="5">Sales tax refund for EV purchased in Palo Alto by Palo Alto residents (8% reduction)</td><td colspan="3">75% of vehicles are electric by 2030</td></tr>
<tr><td colspan="2"></td><td>Develop Priority parking program for EVs</td><td>Investigate options for community-scale bulk purchasing of EVs</td><td colspan="8">Bulk purchase program for EV's and EVSE equipment to bring down costs of EV purchases</td></tr>
<tr><td colspan="2">Require pre-wiring of electric vehicle charging infrastructure</td><td colspan="9">Require electric vehicle supply equipment (EVSE) actually installed for all new residential / commercial construction, additions, and remodels</td></tr>
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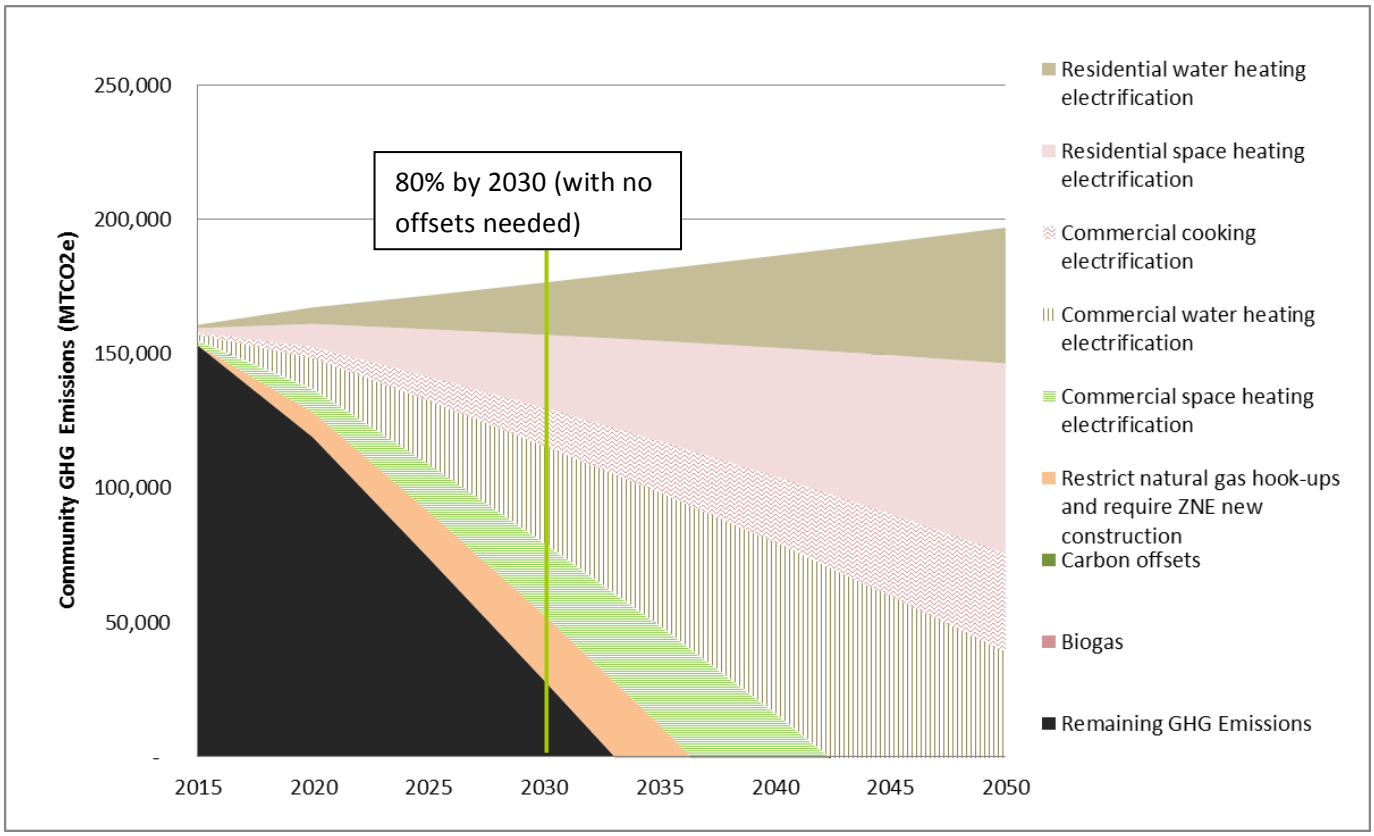
</table>

For the natural gas sector, the proposed rate of electrification of natural gas equipment would result in the achievement of sufficient emissions reductions by 2030 without the need to purchase carbon offsets. This scenario assumes all new construction is all-electric and net zero energy, along with significantly more water heating and space heating electrification in the existing commercial building sector by 2030. The associated net present value associated with natural gas strategies is estimated at $157 million (savings), largely driven by the financial savings associated with net zero energy new construction.

Figure 4. Possible Natural Gas Sector Strategies to Achieve 2030 Target



Strategy Code	Natural Gas Strategies	Implementation Level by 2030	Annual Adoption Rate	Implementation Description
NG-RES-1	Residential water heating electrification	70%	7%	Assume significant portion of residential water heaters could be replaced with electric if we start immediately
NG-RES-2	Residential space heating electrification	60%	5%	Residential space heating more difficult and less cost-effective than water heating
NG-COMM-1	Commercial water heating electrification	50%	6%	Assume small commercial buildings have a gas storage tank water heater that is replaced by an air source heat pump water heater. Assume large commercial buildings have a gas boiler that is replaced with solar hot water and electric resistance heating.
NG-COMM-2	Commercial space heating electrification	50%	6%	Assume small commercial buildings have gas-pack furnaces that are replaced by a packaged heat pump heater. Assume large commercial buildings have gas boilers that are replaced with heat recovery chillers .
NG-COOK-1	Commercial cooking electrification	40%	3%	Given the industry, fairly aggressive, but minimal impact on overall cost of scenario

Strategy Code	Natural Gas Strategies	Implementation Level by 2030	Annual Adoption Rate	Implementation Description
NG-GAS-1	Restrict natural gas hook-ups and require ZNE new construction	100%	100%	All new construction achieves ZNE, no gas hook-up (both residential and commercial)
NG-OFF-1	Carbon offsets	0%	0.0%	No offsets needed to achieve 80% by 2030 goal
NG-OFF-2	Biogas	0%	0.0%	No biogas needed to achieve 80% by 2030 goal

2030 Possible Natural Gas Roadmap

		2015	2017	2019	2021	2023	2025	2027	2029	2030
NG-RES-1 & NG-RES-2 Residential water heating / space heating - fuel switch	Replace on burnout pathway	Information services for electric water heaters/ space heating systems		Pilot 24-hour hotline	Full implementation of 24-hour hotline for electric water heater replacement			Require all water heaters / space heating systems be replaced with electric at end-of-life		
	Voluntary retrofit pathway	Develop utility program for electric water heater/space heating system replacements, pilot electrification of a sample of homes		Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed				Require electrification as part of all water heaters / space heating system retrofit projects		
	Institutional pathway	Streamline permitting process for electric water heaters / space heating systems		Work with local distributors and contractors to implement upstream incentive programs						
	Time of sale pathway	Develop energy benchmarking and disclosure time-of-sale ordinance for residential		Voluntary time-of sale ordinance for energy efficiency and electrification (incentives and recognition program)			Mandatory time-of-sale ordinance for completing energy efficiency and electrification			

		2015	2017	2019	2021	2023	2025	2027	2029	2030
NG-COMM-1 & NG-COMM-2 Commercial water heating / space heating - fuel switch	Tenant improvement pathway	Information and outreach related to tenant improvement building permits		Voluntary program (e.g., incentives, checklists, expedited permitting, reduced fees) for electrification of space and water heating equipment				Require electrification as part of all water heaters / space heating system retrofit projects		
	Voluntary retrofit pathway	Develop utility program for electric water heater/gas heating system replacements		Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed						
	Institutional pathway	Streamline permitting process for electric water heaters / space heating systems		Work with local distributors and contractors to implement upstream programs						
	Time of sale pathway	Education and outreach to vendors, landlords, real estate community		Develop voluntary time-of-sale requirement for energy upgrades				Develop mandatory time-of-sale requirement for energy upgrades		

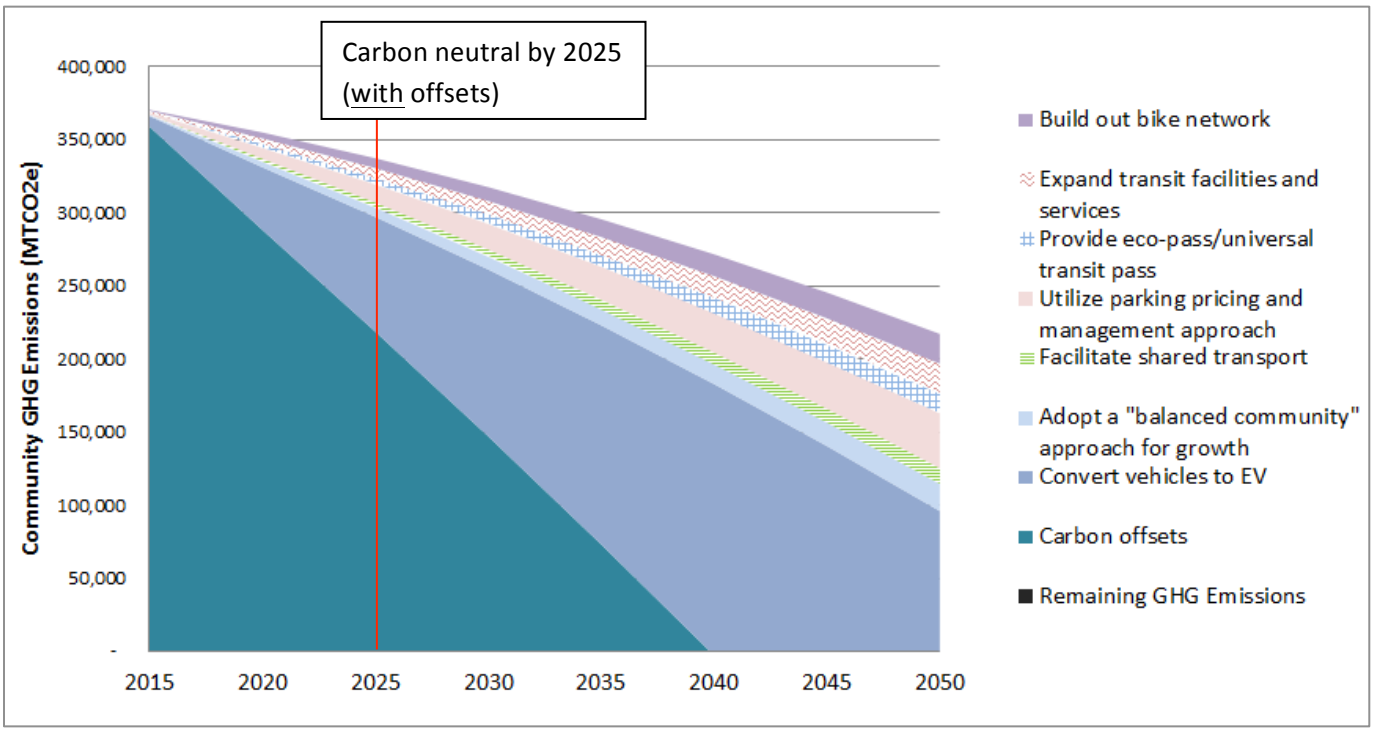
		2015	2017	2019	2021	2023	2025	2027	2029	2030
N-OFF-1 and NG-INF-1 Green gas, offsets and new utility business model to support carbon neutrality	Green gas pathway	Implementation of voluntary "Palo Alto Green Gas" program	Assess costs of carbon offsets and biogas for all natural gas usage in the community	Purchase of carbon offsets and/or biogas with goal of 100% by 2025						
	Infrastructure pathway	implement study of natural gas distribution system and impacts of reduced natural gas consumption		Develop roadmap for staged/planned reductions in specific areas of the city (which neighborhoods are likely to be most impacted/early adopters)			Actively manage reductions in natural gas delivery			
	Financing and rates pathway	Assess appropriate restructuring of natural gas and electricity rates for electrification		Restructure natural gas & electricity rates to support fuel switching to electricity			Continue to support policy and long term planning for restructuring gas utility that will minimize financial risks to rate payers or bond-holders			

		2015	2017	2019	2021	2023	2025	2027	2029	2030
NG-INF-2 Increase local distributed generation in Palo Alto	New construction pathway: green building ordinance	Consider ZNE for larger residential for 2017 code cycle		Consider ZNE for some commercial buildings and no new natural gas hookups in residential by 2025						
	Existing buildings pathway	Release LIDAR as open data	Continue to support bulk purchase programs, PACE financing to bring down costs of solar PV panels							
	Infrastructure pathway	Conduct a distribution system / renewables impact study to determine the most cost-effective methods to stabilize the local distribution grid		Install smart meters in all commercial and residential buildings		Require "smart" inverters to control impacts of solar intermittency				

California Moonshot: 100% carbon neutral by 2025 (100x25)

For the California Moonshot goal, the project team explored what might be at the outer limits of feasibility for each strategy by 2025. For both the transportation and natural gas sectors, aggressive levels of implementation were assumed for each strategy, combined with purchase of offsets for Palo Alto to achieve carbon neutrality by 2025.

Figure 5. Possible Transportation Sector Strategies to Achieve 2025 Target



Strategy Code	Transportation Strategy Name	Implementation Level by 2025	Implementation Description
T-FAC-1	Build out bike network	30%	30% of class II bike lanes converted to protected bike lanes Increase bike boulevard mileage from 22-25 miles Expand bike share to 9 stations per square mile
T-FAC-2	Expand transit facilities and services	20%	Achieve 20% of target ridership of Caltrain modernization Expand SamTrans, VTA and Palo Alto shuttles by 40%
T-FAC-3	Facilitate shared transport	50%	Achieve 50% of current levels of SF casual carpool rates, pro-rated for Palo Alto
T-INC-1	Provide eco-pass/universal transit pass	50%	50% of residents and employees have Universal Transit Passes
T-INC-2	Utilize parking pricing and management approach	30%	30% of sites have parking pricing
T-LU-1	Adopt a "balanced community" approach for growth	10%	Target 3.2 jobs-housing balance (currently at 3.34)
T-EV-1	Convert vehicles to EV	50%	50% of vehicles converted to electric
T-PT-1	Carbon offsets	100%	Purchase offsets for remaining emissions

2025 Possible Transportation Roadmap

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Objective: Expand non-auto mobility options	T-FAC-1 Build out bike network for all ages and abilities	Expand bikesharing program by identifying next 10-15 sites, funding and coordination with future development		Build bike stations (parking/shower/locker facilities) near public transit hubs/key destinations /transfer points			Achieve 9 bike share stations per square mile (81 stations)					
			Identify Class II bike lanes for upgrade to protected bike lanes (also know as "cycle tracks") and integrate with bicycle boulevards		Achieve 15% of class II bike lanes converted to protected bike lanes				Achieve 30% of class II bike lanes converted to protected bike lanes			
	T-FAC-2 Expand transit facilities and services	Palo Alto TMA launched to support alternatives to driving	Continue to explore ways to expand service on local bus/shuttle routes related to SamTrans, VTA and Palo Alto shuttles. Assess needs and opportunities for increased service and ridership (links to provide eco-pass, universal transit pass)				Expand public transit ridership by 40% by 2025					
		Advocate for major upgrades to reliability, frequency, and capacity of Caltrain service. Assess potential for below grade Caltrain improvements			Work with Caltrain to implement major upgrades to reliability, frequency, and capacity of Caltrain service ahead of 2040 timeline							
		Build political support for bus rapid transit along El Camino Real and cross-town Dumbarton			Provide a dedicated bus lane and signal priority for El Camino Real Bus Rapid Transit.							
	T-FAC-3 Facilitate shared transport		Palo Alto TMA to assess opportunities to increase availability and utilization of vanpools		Provide incentives to expand availability and utilization of vanpools							
		Encourage third-party developers to explore data-driven transit solutions through competitions, hack-a-thons, etc		Implement cohesive data platform to support Mobility as a Service (MaaS)								
			Designate curb space for rideshare/carpool pick-up and drop-off downtown, and at Caltrain stations		Discount parking for carpools, paid parking refund for vehicles parked in public lots or on-street							

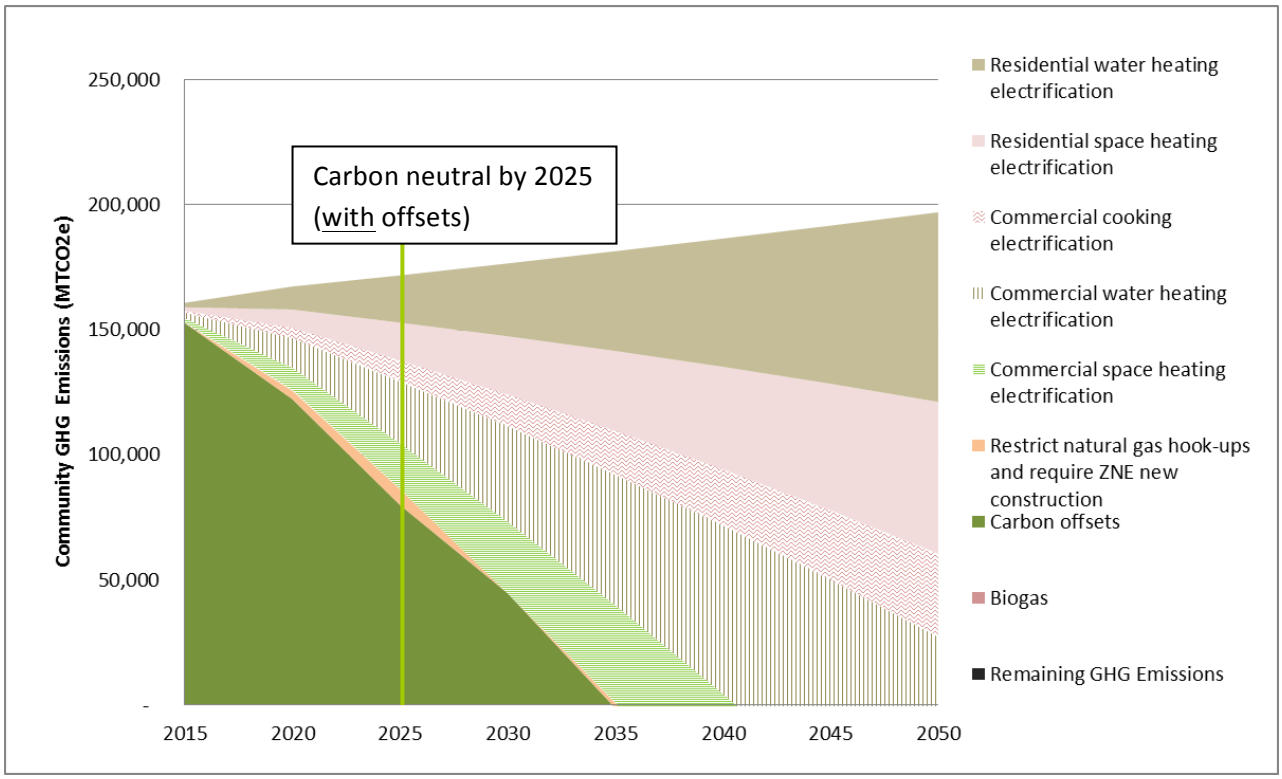
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Objective: Create right financial incentives for alternatives	T-INC-1 Provide eco-pass/universal transit pass	Require Caltrain go-pass as requirement for MF development	Expand requirements to include additional residential new construction and significant renovation projects within 0.5 miles of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					50% of Palo Alto residents have universal transit pass		
		Require Caltrain go-pass as requirement for large office developments	Expand requirements to include all employers within 0.5 mile of Caltrain station		Expand requirements to include universal transit pass (Caltrain, VTA, Samtrans)					50% of Palo Alto employees have universal transit pass		
	T-INC-2 Utilize parking pricing and management approaches		Incentivize unbundling of parking costs from lease/sale of commercial/residential units			Require unbundling of parking costs from lease/sale of commercial/residential units				Eliminate requirements for provision of off-street parking for new commercial/residential		
		Incentivize employers to offer employees option to receive transportation benefits instead of parking benefits (feebates, etc)			Require employers to offer employees option to receive transportation benefits instead of parking benefits							
			Adopt on-street parking vacancy target	Use meters/permits/time limits to manage parking demand in congested areas, along with mobile apps								
			Monitor occupancy and availability of on-street parking regularly									

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Objective: Implement land-use development approaches	T-LU-1 Adopt Comp Plan Scenario 4 (Modified)	Replace zoning restrictions on residential unit density with a cap on average daily vehicle trips generated		Provide incentives for growth and development in transit-accessible areas (e.g., tying allowable floor-to-area ratios to reductions in VMT and other sustainability measures)								
		CompPlan 2030 underway	Through CompPlan 2030, continue to identify areas for increased density and potential future development		Enable/support low-traffic/low-carbon mixed-use development, in specific areas through zoning, complete streets requirements and other land use strategies							

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
LEVER: Reduce carbon intensity of vehicular travel	T-EV-1 Convert vehicles in Palo Alto and surrounding region to EVs	Develop and implement EV charging infrastructure plan for city City fleet vehicles lead the way: electric school buses, garbage trucks, etc		Support and incentivize public & private EV charging infrastructure through reducing permitting fees/streamlining process	Sales tax refund for EV purchased in Palo Alto by Palo Alto residents (8% reduction)					50% of vehicles are electric by 2050		
			Develop Priority parking program for EVs	Investigate options for community-scale bulk purchasing of EVs	Bulk purchase program for EV's and EVSE equipment to bring down costs of EV purchases							
		Require pre-wiring of electric vehicle charging infrastructure		Require electric vehicle supply equipment (EVSE) actually installed for all new residential / commercial construction, additions, and remodels								
			Incentivize automakers to design improved EVs through kickstarter campaign (similar to Automotive X Prize)									
		Engage with EV car dealerships to simplify sales process and promote EV educational resources		Collaborate with and promote EV charging apps (e.g. PlugShare)	Smart phone apps to provide real-time traffic information, and provide reservation services and map of available EV charging stations.							
		Develop behavior-change campaign(s) to encourage residents and employees to purchase EV's, utilize public charging stations.		Monitor purchases of EV's, installation of charging stations, to determine whether uptake is meeting targets. Adjust targets and behavior change campaigns accordingly.								

In the natural gas sector, this scenario includes targets such as converting all residential water heaters to electric by 2025, as well as a substantial percent of commercial water heating and space heating technologies. This scenario is estimated to result in a net present value of $28 million (savings), which is inclusive of $13 million (cost) spent on offsets from 2016-2025.

Figure 6. Possible Natural Gas Sector Strategies to Achieve 2025 Target



Strategy Code	Natural Gas Strategy Name	Implementation Level by 2025	Annual Adoption Rate	Implementation Description
NG-RES-1	Residential water heating electrification	100%	10%	Assume all residential water heaters could be replaced with electric if we start immediately
NG-RES-2	Residential space heating electrification	40%	5%	Residential space heating more difficult and less cost-effective than water heating
NG-COMM-1	Commercial water heating electrification	60%	6%	Assume small commercial buildings have a gas storage tank water heater that is replaced by an air source heat pump water heater. Assume large commercial buildings have a gas boiler that is replaced with solar hot water and electric resistance heating.
NG-COMM-2	Commercial space heating electrification	60%	6%	Assume small commercial buildings have gas-pack furnaces that are replaced by a packaged heat pump heater. Assume large commercial buildings have gas boilers that are replaced with heat recovery chillers .
NG-COOK-1	Commercial cooking electrification	30%	3%	Given the industry, fairly aggressive, but minimal impact on overall cost of scenario
NG-GAS-1	Restrict natural gas hook-ups and require ZNE new construction	60%	60%	Of new construction between 2016-2025, only 60% achieve ZNE, no gas hook-up (both residential and commercial)
NG-OFF-1	Carbon offsets	100%	100%	Purchase offsets for remaining emissions
NG-OFF-2	Biogas	100%	0%	Procure biogas for remaining gas use

2025 Possible Natural Gas Roadmap

<table>
<tr><th></th><th></th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th><th>2024</th><th>2025</th></tr>
<tr><td rowspan="4">NG-RES-1 & NG-RES-2 Residential water heating / space heating - fuel switch</td><td>Replace on burnout pathway</td><td colspan="2">Information services for electric water heaters/ space heating systems</td><td>Pilot 24-hour hotline</td><td colspan="3">Full implementation of 24-hour hotline for electric water heater replacement</td><td colspan="5">Require all water heaters / space heating systems be replaced with electric at end-of-life</td></tr>
<tr><td>Voluntary retrofit pathway</td><td colspan="2">Develop utility program for electric water heater/space heating system replacements, pilot electrification of a sample of homes</td><td colspan="4">Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed</td><td colspan="5" rowspan="2">Require electrification as part of all water heaters / space heating system retrofit projects</td></tr>
<tr><td>Institutional pathway</td><td colspan="2">Streamline permitting process for electric water heaters / space heating systems</td><td colspan="4">Work with local distributors and contractors to implement upstream incentive programs</td></tr>
<tr><td>Time of sale pathway</td><td colspan="2">Develop energy benchmarking and disclosure time-of-sale ordinance for residential</td><td colspan="2">Voluntary time-of-sale ordinance for energy efficiency and electrification (incentives and recognition program)</td><td colspan="7">Mandatory time-of-sale ordinance for completing energy efficiency and electrification</td></tr>
</table>

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
NG-COMM-1 & NG-COMM-2 Commercial water heating / space heating - fuel switch	Tenant improvement pathway	Information and outreach related to tenant improvement building permits		Voluntary program (e.g., incentives, checklists, expedited permitting, reduced fees) for electrification of space and water heating equipment				Require electrification as part of all water heaters / space heating system retrofit projects				
	Voluntary retrofit pathway	Develop utility program for electric water heater/gas heating system replacements		Evaluate replacement rates. Increase incentives for electric water/space heating systems if needed								
	Institutional pathway	Streamline permitting process for electric water heaters / space heating systems		Work with local distributors and contractors to implement upstream programs								
	Time of sale pathway	Education and outreach to vendors, landlords, real estate community		Develop voluntary time-of-sale requirement for energy upgrades				Develop mandatory time-of-sale requirement for energy upgrades				

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
N-OFF-1 and NG-INF-1 Green gas, offsets and new utility business model to support carbon neutrality	Green gas pathway	Implementation of voluntary "Palo Alto Green Gas" program	Assess costs of carbon offsets and biogas for all natural gas usage in the community	Purchase of carbon offsets and/or biogas with goal of 100% by 2020								
	Infrastructure pathway	implement study of natural gas distribution system and impacts of reduced natural gas consumption		Develop roadmap for staged/planned reductions in specific areas of the city (which neighborhoods are likely to be most impacted/early adopters)			Actively manage reductions in natural gas delivery					
	Financing and rates pathway	Assess appropriate restructuring of natural gas and electricity rates for electrification		Restructure natural gas & electricity rates to support fuel switching to electricity			Continue to support policy and long term planning for restructuring gas utility that will minimize financial risks to rate payers or bond-holders					

APPENDIX E – S/CAP Wedge Chart Details

The S/CAP represents conservative estimates of costs and GHG reduction potential, particularly related to cost curves associated with electric vehicles, and solar PV pricing. Furthermore, GHG potential associated with Mobility as a Service is conservative due to lack of data.

In this section, we describe the range of S/CAP strategies *analysed* in support of Appendix C wedge charts for 2025, 2030 and 2050.

Transportation Levers, Strategies and Actions

A suite of transportation related levers and strategies were considered as part of the three scenario analyses.

T-FAC-1: Expand bicycle network and infrastructure

This strategy focuses on leveraging the Palo Alto Bicycle and Pedestrian Transportation Plan, to support the City in meeting a goal of doubling the rate of bicycling for both local and total work commutes to 15% and 5%, respectively, by 2020. The S/CAP project assessed additional targets associated with specific actions to evaluate the potential greenhouse gas emissions savings for 2025, 2030 and 2050.

Actions modeled:

- Convert all class II bike lanes to protected bike lanes (PBL)
- Increase bike boulevard mileage from 22-32 miles
- Expand bike share to 28 stations per square mile (currently 5 stations citywide)

T-FAC-2: Expand transit facilities and services

This strategy identifies transit agency expansion and improvement plans under way, associated opportunities to improve service frequency, speed, reliability and capacity. However, to implement these transit expansion strategies, the key action of the City is to collaborate with neighboring jurisdictions in Santa Clara County and along the entire San Francisco Peninsula to advocate for major public investment in transit service and infrastructure and to define these projects in a way that maximizes future capacity, ridership, convenience, reliability and frequency of service.

Actions modeled:

- Achieving the Caltrain modernization ridership rates targeted in 2040
- Expand SamTrans, VTA and Palo Alto shuttle ridership by 200%
- El Camino Real and Dumbarton Bus Rapid Transit

T-FAC-3: Facilitate shared transport options

This strategy focuses on facilitating the use of shared travel options, including transportation network companies (TNCs) for conventional carpooling as well as dynamic ridesharing particularly along the US 101 corridor and for first mile/last mile travel options.

Actions modeled:

- Dynamic ridesharing based on San Francisco casual carpool rates, with Palo Alto share proportionate to Palo Alto Caltrain ridership
- Actions include designating curb space for rideshare/carpool pick-up and drop-off downtown, and at Caltrain Stations.

T-INC-1: Provide universal transit access

Beginning in 2014, the City of Palo Alto offered a free Caltrain Go-Pass to all of its benefits-eligible employees working at downtown locations. As a condition of development, the City of Palo Alto currently requires developers of selected properties to purchases Caltrain Go-Passes for all full-time employees of tenants. The new Palo Alto Transportation Management Association is working on a bulk-discount VTA eco-pass program for downtown employees. This strategy assumes additional significant and widespread adoption of a universal transit pass including all transit agency programs (Caltrain Go-Pass, SamTrans Way2GoPass, and VTA EcoPass).

Actions modeled :

- Expanded Universal Transit Pass (UTP) - Caltrain GoPass, SamTrans Way2GoPass, and VTA Ecopass, for all residents and employees

T-INC-2: Utilize parking pricing and management

The price and availability of parking at one's destination is a key factor in travel mode choice, with free on-street parking and required off-street parking (i.e., parking minimums) creating an effective subsidy for travel by cars. This strategy focuses on actions such as unbundling parking costs from lease/sale of commercial and residential units, adopting on-street parking vacancy target, monitoring occupancy and availability of on-street parking regularly, and requiring employers to offer the option of receiving transportation benefits instead of parking benefits (e.g., parking cash-out, or feebate program).

Actions modeled:

- All employment sites institute parking pricing, parking cash-out, parking feebate equivalent to market price of parking
- Full cost pricing of residential and commercial parking (unbundling or eliminating minimum parking requirements)

T-LU-1: Pursue jobs-housing balance

Understanding that land use and jobs-housing balance can be controversial issues, this strategy was included to better understand the potential impact of a more balanced ratio of jobs and housing with the City. The California Department of Finance considers a 1.5 jobs-to-housing ratio to be desirable. As such, the S/CAP project including analysis of "what it would take" to achieve this type of balance in Palo Alto. Infill growth in specific areas of Palo Alto was explored, in addition to potential new housing through "backyard cottage" and other types of accessory dwelling units.

Actions modeled:

- Target jobs-housing balance of 1.44 with growth in specific areas (e.g., Stanford Research Park, downtown core, Stanford Shopping Center, etc), by developing mixed use and higher density in targeted areas.

T-EV-1: Convert vehicles to electric vehicles

In addition to reducing vehicle-miles traveled, reducing the carbon content of vehicle fuels is an another important strategy for overall reductions in transportation emissions. Electric vehicle technology continues to improve rapidly, with significant uptake regionally and in Palo Alto. This strategy was assessed for the GHG impact of different rates of adoption of electric vehicles.

Actions modeled:

- Increased target electric vehicle adoption rates through incentives, bulk purchase programs and expanded electric vehicle charging infrastructure

Natural Gas Levers, Strategies and Actions

A suite of natural gas related levers and strategies were considered as part of the scenario analysis.

NG-RES-1: Electrify residential water heating

For existing homes, identify and implement actions to reduce fuel switching costs, require upgrades at key leverage points (e.g., time-of-sale and/or major renovation) and make it easy for the community to find appropriate products for their needs.

Actions modeled:

- Increased target adoption of electrification of water heaters in homes

NG-RES-2: Electrify residential space heating

For existing homes, identify and implement actions to reduce fuel switching costs from furnaces to electric technologies (e.g., air source heat pumps), require upgrades at key leverage points (e.g., time-of-sale) and make it easy for the community to find appropriate products for their needs.

Actions modeled:

- Increased adoption of electric technologies for heating homes

NG-COMM-1: Electrify commercial water heating

This strategy focused on the estimated GHG emissions savings potential of electrifying commercial water heating. The S/CAP project assumed that small commercial buildings have a gas storage tank water heater that would be replaced by an air source heat pump water heater. We also assumed that of large commercial buildings with gas boilers would be replaced with solar hot water and electric resistance heating.

Actions modeled:

- Increased adoption of electrification of water heating in commercial buildings

NG-COMM-2: Electrify commercial space heating

This strategy focused on the estimated GHG emissions savings potential of electrifying commercial space heating. The S/CAP project assumed that small commercial buildings had gas-pack furnaces that would be replaced by a packaged heat pump heater. This also assumes that large commercial buildings have gas boilers that would be replaced with heat recovery chillers.

Actions modeled:

- Increased adoption of electrification of space heating in commercial buildings

NG-COOK-1: Electrify commercial cooking

Commercial cooking equipment is notoriously inefficient, with additional challenges associated with "user experience" and impacts on final product that need to be considered in retrofitting with electric equipment. For the purposes of this S/CAP analysis, this strategy focused on opportunities to replace gas cooking equipment with electric cooking equipment in restaurants currently using gas cooking equipment by the target year. Cooking equipment considered include combination ovens, convection ovens, fryers, griddles, steamers, and induction ranges.

Actions modeled:

- Increased adoption of electric cooking equipment in commercial food service

NG-GAS-1: Eliminate natural gas use through zero net energy new construction

Natural gas usage in the new construction (and major remodels) must be reduced in addition to existing buildings. This strategy focuses on restrictions on natural gas usage in the new construction sector being tied to California's zero net energy goals. Specifically, this analysis assumed that certain percentages of new commercial construction and new residential construction are built to a net zero standard - relying on rooftop PV to provide 100% of energy needs and relying on air source heat pumps and heat pump hot water heater to provide all space and water heating needs.

Actions modeled:

- Increased adoption of zero net energy buildings ahead of state targets with all-electric buildings

NG-OFF-1: Purchase carbon offsets

This strategy would move from the voluntary City of Palo Alto Utilities GreenGas Program to buy offsets or credits to immediately make the entire natural gas supply carbon neutral in Palo Alto. Then focus on designing and implementing strategies for fuel switching, efficiency and policy drivers to move away from natural gas. As part of this strategy, Palo Alto would explore the allocation of purchased offsets to fund local GHG reduction initiatives.

Actions modeled:

- Purchase carbon offsets[2]

NG-OFF-2: Procure biogas

An alternative to carbon offsets is to procure biogas instead of fossil fuel-based natural gas supply. This was previously assessed by City of Palo Alto Utilities with costs found to be prohibitive. This

[2] The quality of carbon offsets varies significantly in the market. Our analysis assumed high quality offset products like Green-e climate certified carbon offsets.

strategy is included in the analysis as an option, but due to cost considerations and supply constraints, was not selected in the proposed scenarios.

Actions modeled:

- Procure biogas as a carbon neutral gas supply

APPENDIX F – Climate Adaptation and Vulnerability Analysis

The objective of the City of Palo Alto Vulnerability Analysis and Adaptation Roadmap (Adaptation Roadmap) is to examine a broad spectrum of the community's potential climate change vulnerabilities and prioritize adaptation responses based on the greatest risks, needs, and synergies with related planning efforts. The Adaptation Roadmap is meant to guide adaptation planning by identifying important City-owned and community assets that are vulnerable to climate change impacts, assessing the risk that climate change poses to those assets, and recommending response actions that the City should integrate into its planning efforts to mitigate that risk. The overall goal is to establish a stronger framework for gathering data, making decisions, and prioritizing actions that will improve the City's resilience to climate change over time.

The Adaptation Roadmap assesses vulnerabilities for the following eleven functional categories of community assets, which include City-owned or operated facilities deemed critical for operations, utility services, and risk management, and other assets that are important to community health, safety, and well-being:

1. Emergency Response and Communications
2. Energy Security and Infrastructure
3. Water Security and Supply Infrastructure
4. Wastewater Management
5. Stormwater Management
6. Transportation Infrastructure
7. Shoreline Flood Management
8. Public Health
9. Buildings and Property
10. Solid Waste/Hazardous Materials Management
11. Natural Areas/Ecosystems

Palo Alto's greatest risks related to climate change are a product of the City's bayside setting, the inherent sensitivities of its Mediterranean climate, and its dependence on imported water from the distant Sierra Nevada mountains as its primary water supply. Some of the City's critical utility infrastructure, including the Regional Water Quality Control Plant and the Utility Control Center, is located in a flood basin or in close proximity to the low-lying shoreline where risk of damage or disruption from sea level rise is significant. Climate change is expected to bring hotter and drier summers and winter storms that are predicted to be fewer in number but higher in intensity. These changes can stress natural habitats and public health while posing a potentially serious risk to the long-term reliability of the City's potable water supply and hydroelectric supply. Based on this study, the City-owned and community assets at highest risk from climate change by the year 2100 include the following:

1. Property and infrastructure located in areas along the Bay shore prone to coastal flooding, including the areas east of Highway 101, where the RWQCP, Municipal Services Center, Utilities Control Center, Utilities Engineering Center and the Palo Alto Airport are located. Current levees are not designed to protect these assets from sea level rise;

2. The City's long-term potable water supply, which is largely dependent on runoff from the Sierra Nevada Mountains, especially during dry years;

3. The City's hydroelectric supply, which is vulnerable to a reduction in Sierra mountain snowpack;

4. Road transportation assets including streets and highway approaches which are located in flood-prone areas along the Bay shore;

5. The health and well-being of the most vulnerable of the City's residential populations, and its natural inhabitants (flora and fauna), which can experience severe stress from extreme heat, drought and extreme precipitation events.

Palo Alto is already engaged in multiple planning efforts that address some or all of these risks, but the Adaptation Roadmap represents the City's first broadly coordinated effort to identify and document vulnerabilities across a broad range of community assets and assess the risk of climate-related impacts to those assets over near-term (to 2050) and longer-term (to 2100) planning horizons.

Coastal Flooding

Adaptation strategies for sea level rise should be woven into a comprehensive vision for the Bay shore that addresses climate change along with other issues including water quality, the protection of the Baylands ecology, public access and recreation. Many of the shoreline adaptation challenges faced by Palo Alto arise from decades of managing stormwater, water supply, and flood protection as separate systems rather than using an integrated approach incorporating broad stakeholder engagement, multi-objective planning, and vulnerability assessment that recognizes the dependencies and relationships between systems and the potential for exacerbating risk of failure to critical assets. Moreover, much of the shoreline infrastructure, including levees, flood control facilities and waste water treatment plants, is more than 50 years old, built in the Clean Water Act era when federal and state grants covered most costs. Even though concerns about maintaining the area's infrastructure have been growing for decades, a commensurate increase in funding has not occurred. Beyond the price tag, the regulatory and institutional challenges of doing multi-benefit projects remain substantial. Most clean water regulations, flood control specifications, and Bay fill policies were written 20-50 years ago, when conditions were quite different than they are today or what they are projected to be in the future.

Retreating from rising seas is inherently difficult in areas where the shoreline has been developed, presenting enormous societal and political challenges that are likely to generate decades-long debates. Strategies that focus on strengthening or maintaining the existing levee alignment can buy time for much harder decisions to be made. The current Strategy to Advance Flood protection, Ecosystems and Recreation along the Bay (SAFER Bay) project, focused on the San Francisquito Creek, is planning improvements to existing coastal levees while also examining asset re-location, real estate easements, and horizontal levees. Innovative approaches, like using horizontal levees to restore protective marshes and integrate ecosystem restoration with management of wastewater, sediment and flooding are promising for Palo Alto but require more study and can be stymied by current regulations. In general, regulation needs to evolve along with adaptation strategies, continuing to protect the environment and natural habitats but allowing room for innovation and response actions as the environment changes over the next century and beyond. There are lessons to be learned from

international experience, such as the coastal armoring approaches used by the Dutch, but the ecological, political and cultural landscape of the Bay is quite different from other places, and appropriate adaptation strategies are highly dependent on local geomorphology and ecology, the assets at risk, the appetite for risk, and the resources available.

Water Supply

The City's current water supply is highly vulnerable to drought, but the risk of failure is uncertain. The City is dependent on City and County of San Francisco's Regional Water System (RWS), operated by San Francisco Public Utilities Commission (SFPUC), for the bulk of its long-term water supply. During periods of extended drought, the ability of SFPUC to supply its wholesale customers (including City of Palo Alto) is at risk, though SFPUC has reported as recently as 2009 that it does not consider its regional supply to be at significant risk from climate change through the year 2030. However, California's current drought, now in its fourth year, is putting added emphasis on long-term water security and forcing public agencies to redouble conservation efforts and expand contingency planning. Accordingly, SFPUC and the City of Palo Alto are increasing efforts to improve conservation, upgrade storage and delivery systems, and diversify local water supplies.

Hydropower

Long-term changes in precipitation patterns caused by climate change represent significant risk to the availability of hydropower for the City, due to expected higher incidence of severe droughts, loss of Sierra snowpack, and wildfires. These climate perturbations will lead to additional stresses on the State's energy system and the reliability of power to the City. As a result, energy resiliency will become increasingly critical to the City and its utility. The City long term plan for managing energy supplies needs well consider measures around islanding, smart grid, local generation, energy storage and redundant transmission lines.

The MSC, UCC, and Utility Engineering Center, which are all critical to energy operations, face moderate risk from sea level rise by 2050 and significant risk from sea level rise by 2100. Plans should be established to protect these assets, relocate them, or establish redundant operational capabilities in case these facilities become incapacitated during a flooding event.

Critical Transportation Assets

Highway 101 (Bayshore Freeway), the Palo Alto Airport, and surface streets in the Palo Alto floodplain are all at significant risk from sea level rise by the year 2100. Current levees are not likely to adequately protect these assets from sea level rise; the Strategy to Advance Flood protection, Ecosystems and Recreation along the Bay (SAFER Bay) project is planning improvements to these levees. As an intermediate measure, the City should develop contingency plans for temporary loss of these assets.

Many roads and highways in the foothills are in high risk zones for wildfires by the year 2100. The vulnerability of these assets should be better defined, along with consequences of failure and contingency plans in the event they become damaged or inaccessible.

Vulnerable Populations

The City's most vulnerable populations (elderly, low-income and health-compromised residents) face significant risk from extreme heat events by 2100. These populations will also face higher risk of health problems from worsening air quality and new disease vectors. The City has an important role, in partnership with public agencies and community based organizations, to educate and engage the public on climate change issues, and to promote community involvement in actions to reduce climate

change risks, using linguistically and culturally appropriate approaches that are effective for diverse populations.

Summary

Palo Alto, like many cities in the Bay Area, is generally aware of the risks it faces from climate change, but is faced with a dearth of "actionable science" and cost-benefit studies on which to rely for critical decision-making. It is difficult to know how to best apply limited resources when there are so many competing demands for City budgets and staff time. Climate change is inherently complex and its predictions are fraught with uncertainty, adding to the difficulty of building stakeholder consensus to take action. The Adaptation Roadmap provides a compendium of current plans, studies, policies, and actions that are relevant to the City's adaptation planning efforts and provides a framework for making informed decisions on how to best focus resources going forward to increase the City's resilience to an uncertain future.

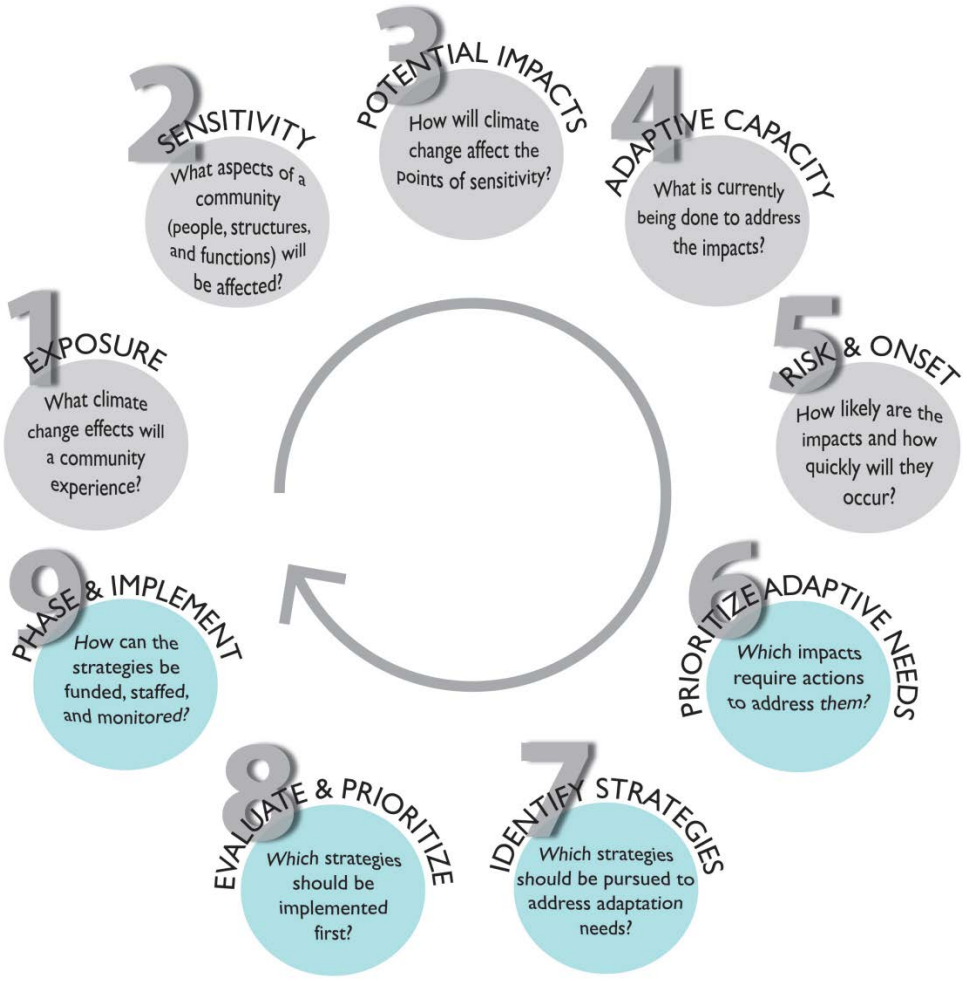
Method

The methodology used to develop the Palo Alto Adaptation Roadmap is derived from the California Climate Adaptation Planning Guide[3] (CCAPG), which recommends a sequence of nine steps in developing strategies to address climate change impacts (see Figure 2.1): (1) assess exposure to climate change impacts; (2) assess community sensitivity to the exposure; (3) assess potential impacts; (4) evaluate existing community capacity to adapt to anticipated impacts; (5) evaluate risk and onset, meaning the certainty of the projections and speed at which they may occur; (6) set priorities for adaptation needs; (7) identify strategies; (8) evaluate and setting priorities for strategies; and (9) establish phasing and implementation.

The first five steps (colored gray) in Figure 2.1 represent the vulnerability assessment, while steps 6 through 9 represent strategy development. The vulnerability assessment helps determine the potential impacts of climate change on community assets and populations. Understanding the extent, potential severity, and likelihood of those impacts enables a community to develop climate adaptation policies and programs to increase resilience to climate change (steps 6 through 9).

Figure 2.1 - The nine steps in adaptation planning development (from CCAPG)

[3] California Emergency Management Agency and California Natural Resources Agency, 2012. California Adaptation Planning Guide.



Setting

Greenhouse gas (GHG) emissions forecasts underlie predictions of future climate change and assessments of potential exposure to climate change impacts. The following passage is extracted from Climate Chapter of the 2013 San Francisco Bay Area Integrated Regional Water Management Plan[4] (IRWMP):

Two GHG emissions scenarios have been commonly used in recent planning documents for California. Scenario A2 (Medium–High Emissions) assumes higher GHG emissions and high growth in population and represents a more competitive world that lacks cooperation in sustainable development (similar to "business as usual"), while B1 (Lower Emissions) is a lower GHG emission scenario that represents social consensus and action for sustainable development. Generally, the B1 scenario might be most appropriately viewed as an optimistic "best case" or "policy" scenario for emissions that will require

[4] Kennedy Jenks Consultants (with Environmental Science Associates), 2013, *San Francisco Bay Area Integrated Regional Water Management Plan*.

fundamental shifts in global policy, while A2 is more of a status quo scenario reflecting real-world conditions incorporating incremental improvements and may be the more realistic choice for decision-makers to use for climate adaptation planning. To date, actual global emissions have more closely tracked, and even exceeded, the A2 scenario put forth in 2000.

Climate change assessments are performed using the output of computer models that project future conditions utilizing GHG emission scenarios as input. These models are not predictive, but provide projections of potential future climate scenarios that can be used for planning purposes. The primary climate variables projected by global climate models (GCMs) that are important for water resources planning in California are changes in air temperature, changes in precipitation patterns, and sea-level rise. A set of six GCMs were run for the two GHG emissions scenarios, A2 and B1, and downscaled to locations in California. The six GCM models used were:

1. National Center for Atmospheric Research (NCAR) Parallel Climate Model (PCM)
2. National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluids Dynamic Laboratory (GFDL) model
3. French Centre National de Researches Meterologiques CNRM3 model
4. NCAR CCSM3 model
5. German MPI ECHAMS model
6. Japanese MIROC3.2 (medium-resolution) model

Based on historical simulations, the selected models are capable of producing a reasonable representation of California's seasonal precipitation and temperature, variability of annual precipitation, and the El Niño/Southern Oscillation.[5]

Statewide Climate Change Projections

All of the models show increased warming throughout the 21st century, with average annual air temperature increasing about 2°F to 5°F by 2050. The Mediterranean seasonal precipitation pattern is expected to continue during the 21st century, with most of the precipitation occurring during winter from North Pacific storms. The hydro-climate (hydrology and weather) is expected to be influenced by the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) with alternating periods of wet and dry water years. In the Sierra Nevada Mountains, there will be some shift to more winter precipitation occurring as rain instead of snow, with a reduction in snowpack accumulation and shifts in runoff patterns, especially during the summer and fall. By 2050, scientists project a loss of at least 25% of the Sierra snowpack.[6]

Bay Area Region Climate Change Projections

Temperature

[5] Cayan, Tyree, and Iacobellis, 2012. *Climate Change Scenarios for the San Francisco Region.* California Energy Commission Publication No. CEC-500-2012-042.

[6] California Department of Water Resources, 2014. Climate Change. www.water.ca.gov/climatechange/ , accessed March 10, 2014).

The historical average annual temperature in the San Francisco Bay Area region is 56.8°F (13.8°C). Overall average air temperatures in the SF Bay Area are expected to rise 2.7°F (1.5°C) between 2000 and 2050 regardless of the GHG emissions scenario, but the A2 and B1 scenarios project increases of 10.8°F (6°C) and 3.6°F (2°C), respectively, by the end of the 21st century. The temperature projections begin to deviate between the A2 and B1 scenarios around mid-century, with the A2 scenario increase about twice the B1 scenario by 2100. Precipitation in the San Francisco Bay Area region is essentially all due to rain, and significant shifts in the timing of precipitation are not expected to occur.[7] The SF Bay Area is likely to continue with a Mediterranean climate of cool wet winters and hot dry summers. Possible changes in precipitation projected by the GCMs are uncertain in part due to the highly variable precipitation that California experiences on an annual and decadal time scale. Up to the year 2050 annual precipitation changes produce mixed results; however there is an indication that conditions will be drier than the historical average in the second half of the century. Looking at averaged projections by month, it is possible to identify greater reductions in precipitation in March and April while November, December and January may remain relatively unchanged. While average conditions may be drier the expectation is that more intense downpours will occur during a somewhat shorter rainy season.

Sea-Level Rise and Coastal Flooding

Sea-level rise is expected to increase the risk of coastal erosion and flooding along the California coast, and higher water levels due to sea-level rise could magnify the adverse impact of storm surges and high waves. Impacts to assets from extreme high tides in addition to net increases in sea level will likely result in increased inundation frequency, extents, and depths leading to catastrophic flooding and coastal erosion. Understanding the extent, depth and duration of inundation and the patterns of erosion will be necessary for characterizing infrastructure vulnerability in coastal areas. The picture is further complicated by the concurrent vertical movement of the land due to tectonic activity. Projections of the relative sea level, the sum of both sea level rise and vertical land movement, are therefore important in the San Francisco Bay area.

Sea level has been measured at the Presidio tide gauge in San Francisco since 1854, with a recorded rise in relative sea level of 7.6 inches (19.3 cm) over the last 100 years.[8] Present sea-level rise projections suggest that the rate of global sea level rise in the 21st century can be expected to be much higher.

California, via the Ocean Protection Council, (OPC, 2013[9]), has adopted the San Francisco Bay region sea level rise projections from the National Research Council (NRC, 2012[10]), which includes an allowance for vertical land motion. For the Bay Area, this study projects 11 inches of sea level rise by 2050 (with a range of 5 to 24 inches) and 36 inches by 2100 (with a range of 17 to 66 inches by 2100.

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[7] Cayan, Tyree, and Iacobellis, 2012.

[8] National Research Council, 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. Washington, DC: The National Academies Press. http://www.nap.edu/catalog.php?record_id=13389 .

[9] State of California Ocean Protection Council, *State of California Sea-Level Rise Guidance Document*, March 2013 update.

[10] National Research Council (NRC), 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.* http://www.nap.edu/catalog.php?record_id=13389

Summary of Current Relevant Planning Initiatives

ESA staff met with City staff from the Palo Alto Department of Public Works and Office of Emergency Services to review critical facilities and functions, and to discuss perceived vulnerabilities and adaptive capacity to climate change impacts. ESA also reviewed the most relevant planning initiatives and documents related to climate change adaptation planning for the City of Palo Alto. Findings and results are summarized below.

City of Palo Alto Comprehensive Plan

The City of Palo Alto Comprehensive Plan, the primary tool for guiding preservation and development in Palo Alto, was last updated from 1998 to 2002. It is currently being revised to bring all the Plan Elements up to date, address changing demographic, economic and environmental conditions, and look forward to 2030. The Current Comprehensive Plan Land Use Map and a City Structure map showing the City's neighborhoods and commercial centers (Figures 8.3 and 8.4, respectively, from the Draft Existing Conditions Report for the Palo Alto Comprehensive Plan Update[11]) are included in Appendix A.

Existing Natural Environment Element

The Natural Environment Element of the existing Comprehensive Plan addresses the management of open land and natural resources in Palo Alto and the protection of life and property from natural hazards. Many of its goals pertain to protecting and conserving Palo Alto's natural resources, natural habitat areas, and the urban forest to provide ecological, economic, and aesthetic benefits for Palo Alto. Its wide-ranging policies cover the use of open space for the preservation of natural resources, the management of natural resources, outdoor recreation, public health and safety, creeks and riparian areas, wetlands, the urban forest, water resources, wildlife, air quality, hazardous materials, solid waste disposal, and energy. It also includes public safety policies for reducing exposure to natural hazards like earthquakes and fires.

The City's major open spaces are in the foothills, including the 1,400-acre Foothill Park, 2,200 acres of Montebello Open Space Preserve, the 610-acre Arastradero Preserve, and 200 acres of Los Trancos Open Space Preserve. Foothill and Arastradero Parks are owned and operated by the City, while Montebello and Los Trancos are operated by the Mid-Peninsula Open Space District.

Other open spaces in the foothills are owned by Stanford University, the Palo Alto Hills Golf and Country Club, and numerous private landowners. Approximately 477 acres of the City's privately owned open space is restricted by the Williamson Act, a State program that creates tax incentives for keeping property in agricultural or open space use. The Williamson Act properties include cattle grazing lands, orchards, and a Christmas tree farm. Approximately 149 acres are considered to be prime farmland.

Along the San Francisco Bay shoreline, open space is contained in what is generally called the Palo Alto baylands. This multi-use area of about 2,100 acres includes the John Fletcher Byxbee Recreation Area, the Palo Alto Municipal Golf Course, the Baylands Athletic Center, the Palo Alto Landfill (part of which has been closed and converted into Byxbee Park), a flood control basin, and several natural salt marshes. The area contains a number of low impact recreational facilities, including hiking and bicycling trails and a boardwalk. It also includes the Lucy Evans Baylands Nature Interpretive Center, a small picnic area, and a sailing station open to windsurfers, kayakers, and small sailboats. Most of

[11] City of Palo Alto, 2014, Draft Existing Conditions Report: Population, Housing and Employment. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 22, 2014.

the area consists of passive open space, including a duck pond and bird sanctuary, restored salt marshes, the Emily Renzel Freshwater Marsh, and some of the most extensive salt marsh and mudflat habitats remaining in the Bay Area.

Locations of parks and open spaces are shown on the Land Use map and the City's Open Space and Water Bodies map (Figure 3.3 from the Draft Existing Conditions Report for the Palo Alto Comprehensive Plan Update[12]) included in Appendix A.

Updated Natural and Urban Environment and Safety Element

The Draft Natural and Urban Environment and Safety Element[13] of the Comprehensive Plan update includes new sections on Climate Change and Adaptation (N2) and Safety and Emergency Management (N8). The Planning and Transportation Commission has recommended changes to the goals, policies, and programs of the Natural and Urban Environment and Safety Element that are still going through a public review process. If those recommendations are accepted and adopted by the City Council in the context of the ongoing Comprehensive Plan Update, there would be a new vision statement and policies as indicated below.

New vision statement: Palo Alto shall preserve its ecosystems, including its open space, creeks, habitats, and air quality while working towards a sustainable urban environment of urban forests, water quality, waste disposal reduction, emergency preparedness, community safety and a plan for climate change mitigation.

New Policy N2.5: The City shall monitor changes to sea level, temperatures, wildfire risk, and other potential changes, taking advantage of state and federal information, and use that information to adapt to the effects of climate change.

- N2.5.1 PROGRAM Prepare a Climate Adaptation Strategy to serve as a companion document to the Climate Protection Plan and identify the ways in which Palo Alto can respond to the predicted changes to its physical environment associated with climate change.

New Policy N2.6: Include in the Capital Improvement Program (CIP) five year plan a priority for infrastructure improvements that address adaptation of critical facilities to climate change.

New Policy N8.1: Facilitate ongoing public education and awareness to prevent loss of life and property from impacts of natural and man-made disasters.

- N8.1.1 PROGRAM Initiate public education programs strongly encouraging that each household in the City be prepared to be self-sufficient for at least 72 hours after a major earthquake, flood, terrorism, pandemic or other major disasters. (Previous Program N-82)
- N8.1.2 PROGRAM Continue to implement the Emergency Services Volunteer program and encourage residents and employees to participate in citywide emergency drills and other public education activities.

[12] City of Palo Alto, 2014, Draft Existing Conditions Report: Biological Resources. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 22, 2014.

[13] City of Palo Alto, 2014,Comprehensive Plan Update, Draft Natural and Urban Environment and Safety Element; http://www.paloaltocompplan.org/plan-contents/natural-environment-element/

Policy N8.2: Focus efforts to reduce exposure to natural hazards in those areas of the City where greatest risks exist.

New Policy N8.7: Monitor and respond to the risk of wild land fire hazards caused by climate change.

- N8.7.1 PROGRAM Consider implementation of CAL FIRE recommended programs in educating and involving the local community to diminish potential loss caused by wildfire and identify prevention measures to reduce those risks.

Utilities and Service Systems

The Draft Existing Conditions Report: Utilities And Service Systems[14] for the Comprehensive Plan update provides background information on the City's extensive utility services, which include water supply and distribution, electricity and natural gas service, collection and treatment of waste water at the Regional Water Quality Control Plant (RWQCP), collection and management of stormwater, collection/recycling/disposal of solid waste, and fiber optics communications. These are all essential services that play vital roles in the economic development and quality of life of the community and are critical for maintaining public health.

Water Supply

Although the Draft Existing Conditions Report contains much of the same information that is provided in the City's 2010 Urban Water Management Plan (discussed later in this section) regarding water supply and conservation, the following two paragraphs from the Report represent additional information:

BAWSCA is developing the Long-Term Reliable Water Supply Strategy (Strategy) to meet the projected water needs of its member agencies and their customers through 2035, and to increase their water supply reliability under normal and drought conditions. The Strategy is proceeding in three phases. Phase I was completed in 2010 and defined the magnitude of the water supply issue and the scope of work for the Strategy. Phase II of the Strategy resulted in a refined estimate of when, where, and how much additional supply reliability and new water supplies are needed throughout the BAWSCA service area through 2035, as well as a detailed analysis of the water supply management projects, and the development of the Strategy implementation plan.[15] The Final (Phase III) Strategy Report is planned for completion by December 2014. This report will incorporate the results of additional work and present the recommended Strategy and the associated Strategy implementation plan (i.e., who will do what by when). Phase III will include the implementation of specific water supply management projects. Depending on cost-effectiveness, as well as other considerations, the projects may be implemented by a single member agency, by a collection of the member agencies, or by BAWSCA in an appropriate timeframe to meet the identified needs. Project implementation will continue throughout the Strategy planning horizon, in coordination with the timing and magnitude of the supply need. The development and implementation of the Strategy will be coordinated with the BAWCSA member agencies and will be adaptively managed to ensure that the goals of the Strategy, i.e., increased normal and drought year reliability, are efficiently and cost-effectively being met. The City is participating in the Strategy and has submitted several potential projects for review.

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[14] City of Palo Alto, 2014, Draft Existing Conditions Report: Utilities And Service Systems. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 8, 2014.

[15] Bay Area Water Supply and Conservation Agency (BAWCSA), 2012. *Phase II Long-Term Reliable Water Supply Strategy Report, Vol I.* July 30. http://bawsca.org/docs/BAWSCA%20PH%20II%20A%20Final%20Report_2012_07_03%20Revised%20073012.pdf

The City anticipates these projects will be evaluated during subsequent project phases, but also as part of several other regional efforts that are simultaneously underway. These efforts include the Palo Alto RWQCP Long Range Facilities Plan and the SCVWD Water Supply and Infrastructure Master Plan. The City is actively participating on all of these efforts in conjunction with the BAWSCA study.

Water supply issues related to hydropower generation, and the risks thereto, can be found in Section 7.2.1.

Wastewater

This functional asset category covers Palo Alto's wastewater collection and treatment infrastructure including the Regional Water Quality Control Plant (RWQCP) operations, sewerage, and outfalls.

The City of Palo Alto's Utilities Department (CPAU) provides wastewater collection, with treatment services provided by the Public Works Department, for the City and its sphere of influence (SOI). The CPAU oversees a wastewater collection system consisting of over 208 miles of sewer lines, while the Public Works Department oversees the treatment of approximately 3.4 billion gallons of wastewater per year.[16] Wastewater effluent is routed to the Palo Alto RWQCP, where it is treated prior to discharge into the San Francisco Bay. In addition to serving the City, the RWQCP serves Mountain View, East Palo Alto Sanitary District, Stanford University, Los Altos, and Los Altos Hills. Approximately 220,000 people live in the RWQCP service area. Of the wastewater flow to the RWQCP, about 60 percent is estimated to come from residences, 10 percent from industries, and 30 percent from commercial businesses and institutions. The RWQCP treats 21 million gallons per day of effluent from all the partner cities.[17]

The RWQCP is designed to have an average dry weather flow (ADWF) capacity of 39 MGD and an average wet weather flow capacity of 80 MGD. Average daily flow is 22 MGD. According to the Background Report, the RWQCP does not experience any major treatment system constraints and capacity is sufficient for current dry and wet weather loads and for future load projections. There are no plans for expansion or to "build-out" the plant; however, in 2012 Palo Alto City Council approved a Long Range Facilities Plan for the RWQCP to ensure capital reinvestment, wastewater treatment services for six agencies, and ongoing water quality control to protect the San Francisco Bay and local creeks.

Stormwater

The City owns and maintains a municipal storm drain system consisting of approximately 107 miles of pipeline and 2,750 catch basins, 800 manholes and 6 pump stations. These improvements are located within the Palo Alto public road right-of-way. Storm drain systems within private streets or private development are privately maintained but are permitted to drain into the public system.

The City's storm drain pipe systems are designed for a 10-year return 6-hour storm event and the hydrology and hydraulics design criteria conform with Santa Clara County Storm Drainage Manual.

In the upper watershed areas, storm drains flow directly to creeks by gravity, but, due to relatively flat slopes and low-lying land, much of the lower watershed is pumped to the creeks through one of the City's six stormwater pump stations. Figure 4.1, from the Comprehensive Plan update, shows

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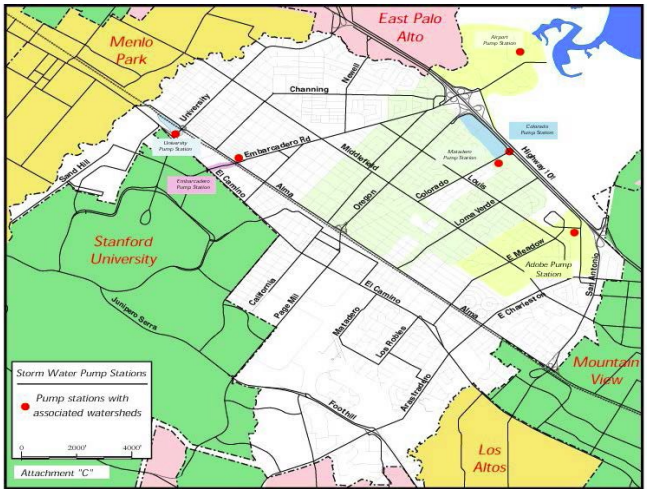
[16] City of Palo Alto, 2014. *Utilities at a Glance.* http://www.cityofpaloalto.org/civicax/filebank/documents/16777 , accessed December 8, 2014.

[17] City of Palo Alto, 2014, Draft Existing Conditions Report: Utilities And Service Systems. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 8, 2014.

locations of stormwater pump stations. In 1989, the City Council created a separate enterprise fund to pay for storm drain maintenance, capital improvements, and stormwater quality programs. The storm drain fee is collected from each property on the City's monthly utility bill.

Figure 4.7: Map of City of Palo Alto pump stations



Source: City of Palo Alto Comprehensive Plan Existing Conditions Report[18]

The storm drain system is separated into four watershed areas, with the storm drains within an area discharging into one of four local creeks: San Francisquito Creek, Matadero Creek, Barron Creek, or Adobe Creek. San Franciscquito Creek drains unimpeded into San Francisco Bay. The other three creeks drain into the Palo Alto Flood Basin (PAFB). The PAFB was constructed in 1956 to provide storage capacity for creek discharges. The Flood Basin is separated from the Bay by levees and tide gates to block the propagation of high tides into the Basin, thereby preserving storage capacity for creek discharge even during high tides. The tide gates are controlled by the Santa Clara Valley Water District. A map of the San Francisquito Creek and Baylands is provided in Appendix B, showing the location of the PAFB and its relationship with surrounding land uses.

Several sections of the City of Palo Alto Municipal Code pertain to stormwater management and protecting water quality related to storm events. In particular, Palo Alto's Flood Hazard Regulations Ordinance (Palo Alto Municipal Code Chapter 16.52) is designed to minimize loss of life, damage to private land development, public facilities and utilities, the need for rescue and relief efforts, business interruptions, and future blighted areas caused by flooding. The ordinance was adopted in order to comply with the National Flood Insurance Program (NFIP). It ensures that property owners construct new and substantially-improved buildings in the Special Flood Hazard Area in a manner that protect the improvements from flood damage. The City Engineer is responsible for enforcing this ordinance, which includes methods and provisions to control the alteration of natural floodplains, stream channels, and protective barriers; to control filling, grading, dredging and other development that can increase flood damage; to regulate the construction of flood barriers which can divert flood waters or

[18] City of Palo Alto, 2014, Draft Existing Conditions Report: Utilities and Service Systems. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 22, 2014.

increase flood hazards in other areas; and to require that uses vulnerable to floods be protected against flood damage at the time of their construction. This ordinance has special regulations for new development within a coastal high hazard area.

City Utility Energy Planning

The City's Utilities department is responsible for energy planning and procurement of natural gas and electricity commodities for use by residents and businesses within city limits. This includes Stanford Shopping Center and Stanford Medical Center, but excludes Stanford University.

Natural Gas

The City's natural gas supply policy is provided by the Gas Utility Long Term Plan (GULP). The key objectives of the GULP are to provide market price, lower delivered gas cost over the long term, promote the deployment of all feasible, reliable, cost-effective energy efficiency measures, reduce the carbon intensity of the gas portfolio, and a reasonable cost, protect the City's interests and maintain access to transportation on par with PG&E's core customers. Because of its small size, and more aggressive gas main replacement program, the gas utility's costs have been around 25% higher than neighboring PG&E costs. PG&E is raising its costs of distribution as a result of its increased focus on safety and main replacements.

As of July 2012, the Utility transitioned its purchasing strategy to market price-based, monthly-adjusted gas supply rates by designing monthly-adjusted gas supply rate; revising the reserve guidelines for Council approval; and conducting customer communication and outreach. Simultaneously, the City is pursuing possible below - market assets available through the Gas Transportation and Storage Settlement by evaluating the pipeline capacity reservation options available and by contracting with PG&E for any pipeline capacity with an estimated cost below the forecasted market value. The City has also developed a Council-directed work stream to meet the gas efficiency targets through the evaluation of the cost-effectiveness of electrification (substituting gas-using appliances for electricity-using appliances) and incorporating cost-effective substitution measures in the implementation plan to meet the gas efficiency targets.

Three major interstate natural gas pipelines operated by PG&E transect Palo Alto. One of them is placed in a relatively low-lying area that runs along Highway 101. The City maintains four delivery "gate" stations where the city receives gas from PG&E transmission system.

Electricity

The policy for electric supply for the City is managed through the Long-term Electricity Acquisition Plan (LEAP). The objectives of LEAP are to meet customer electricity needs through the acquisition of least total cost energy and demand resources including an assessment of the environmental costs and benefits; manage supply portfolio cost uncertainty to meet rate and reserve objectives; enhance supply reliability to meet City and customer needs by pursuing opportunities including transmission system upgrades and local generation.

The primary strategies comprising LEAP focus on acquisition of least total cost resources including an assessment of environmental costs and benefits to meet the City's needs in the long term by evaluating each potential resource on an equal basis by evaluating rate impacts and establishing costs and values for location, time of day and year, carbon, value of renewable supplies and any secondary benefits attributed to the resource. The LEAP strategy includes all electricity resources – conventional energy, local and remote renewable energy supplies, energy efficiency, cogeneration, and demand reduction.

The City of Palo Alto's electric distribution system is connected to Pacific Gas and Electric Company's (PG&E) transmission grid line running along the shoreline via three 115 kV transmission lines at a

single intertie. These three lines provide redundancy and back-up power delivery; all three lines run in a common corridor on the bay side of the City, a corridor that is in close proximity to the Palo Alto Airport. The three PG&E owned transmissions lines supplying the City are located within a PG&E transmission corridor that passes through East Palo Alto. All lines are overhead lines, with two lines located on steel towers and the third on wood poles. The towers and the wood poles are located just 40 feet apart. The common corridor and proximity to an airport means that the City's power supply is susceptible to single events that can affect all three lines, as happened in February of 2010 when a small aircraft hit the power lines resulting in a city-wide power outage for over 10 hours. These 115 kV transmissions lines connect to the Colorado substation where the power is distributed to a network of substations throughout the City's distribution network.

The City has considered potential projects to reduce interruption risks to accident or other event. One potential project, referred to as the Ames Line Project would provide a second 115 kV transmission line from the PG&E grid to the City. This project would reduce the interruption risk between the shoreline transmission line and Palo Alto, but would not reduce Palo Alto's redundancy due to any failure in the shoreline transmission line itself. This Ames Line project is still under consideration.

The City has also considered installing a 230-60kV transformer at SLAC's 230 kV substation and building two underground 60kV lines from SLAC to Palo Alto's Hanover substation which would provide transmission redundancy. This project has not been implemented.

Local Hazard Mitigation Plan (LHMP)

The City of Palo Alto participates in the Association of Bay Area Governments regional Resilience Program. The City's Annex (Section 18) to the 2010 Santa Clara County Local Hazard Mitigation Plan (LHMP) [19] is managed by for the City of Palo Alto Office of Emergency Services (OES), and is updated every five years. The LHMP assesses the technical, managerial, and fiscal capabilities of the City to support hazard mitigation, including a summary of relevant local plans, policies and City ordinances. It also provides a vulnerability assessment of the City's critical facilities (for potable water supply, shelter, fire suppression, emergency response, electricity supply, natural gas supply, stormwater management, wastewater treatment, and city administration), by identifying the facilities (see Table 18-12 of the LHMP) and assessing their exposure to risk from flood, sea level rise, wildfire, and earthquake hazards. Vulnerability to heat and drought is also considered, but the LHMP concludes that the City of Palo Alto does not have unique concerns regarding those hazards.

The 2010 LHMP identifies 50 critical facilities in the following function categories:

- Potable water reservoir
- Potable water booster station
- Potable water/fluoride
- Stormwater pump station
- Electric substation
- Natural gas station

[19] Santa Clara County, 2012; Palo Alto Annex to the Santa Clara County Hazard Mitigation Plan 2011 update; available at: http://www.sccgov.org/sites/oes/PlansPublications/Pages/LHMP.aspx

- Police and Fire Stations
- Regional wastewater treatment
- Utility Control Center (UCC)Emergency operations/recovery
- Shelter
- Administrative Office

The LHMP includes maps showing the overlap of hazard zones with critical facilities, along with tables summarizing the risks and consequences of critical facilities being exposed to these hazards.

The Office of Emergency Services is in the process of updating its critical facilities list in preparation for the 2015 LHMP update. Facility data is being migrated from a spreadsheet-based system to a relational database and analytic risk management software package known as Cal COP (formerly Digital Sandbox DS7), through the Bay Area Urban Area Security Initiative (Bay Area UASI) that is funded by the Department of Homeland Security. New algorithms will help the City determine critical assets going forward.

In 2014, the City became one of the first jurisdictions in the Bay Area to complete a Threat and Hazard Identification and Risk Assessment (THIRA) process. THIRA expands the LHMP assessment, consistent with all hazards planning best practices. The redacted version of the THIRA is posted on the web: www.cityofpaloalto.org/thira

Departmental Responsibilities

The City of Palo Alto operates several departments with capabilities for implementing hazard mitigation strategies. These departments and their roles and responsibilities are summarized as follows:

Community Services Department

The Community Services Department operates the Cubberley Community Center along with various parks (including the Baylands) and other facilities, many of which function as shelters, evacuation points or other uses in a disaster. Further, the CSD Open Space Rangers are trained in wildland firefighting and also support the Police Department in patrolling parks and the Wildland Urban Interface (WUI).

Development Services Department

The mission of the Development Services Department is to work collaboratively with other departments to provide citizens, business owners, developers, and applicants reliable and predictable expectations in the review, permitting, and inspection of development projects that meet the minimum municipal and building code requirements to ensure the health, safety, and welfare of the public. The Building Division ensures construction quality by reviewing construction plans for conformance to building codes, permit processing, and inspecting projects while under construction.

Planning and Community Environment Department

Planning Section

The Planning Section provides staff support for the Planning & Transportation Commission, the Architectural Review Board, the Historic Resources Board, and administers the City's housing

programs as well as preparing and monitoring the Comprehensive Plan and providing long-range planning studies. This division also processes applications for planning entitlements.

Code Enforcement Program

The Code Enforcement Program promotes maintaining a safe and desirable living and working environment, and helps improve the quality of the community

Transportation Division

The Transportation Division enhances safety and mobility in Palo Alto's transportation system while protecting environmental resources and preserving the community's quality of life.

Office of Sustainability

The Office of Sustainability's mission is to lead the organization, residents, and visitors in promoting a culture of environmental sustainability by developing, coordinating, and leading initiatives citywide, regionally, and through partnerships with the community.

Public Safety Departments

The City of Palo Alto has a coordinated structure among its Public Safety departments. This includes, for example, a unified Public Safety Answering Point (PSAP) 911 Center that serves the City as well as Stanford University for law enforcement, fire/EMS, public works, utilities, animal services, and other emergency call types.

Fire Department

The City of Palo Alto Fire Department provides fire and emergency medical services (EMS) to the city and to Stanford University. The large number of businesses and the Stanford University campus often increase the daytime population to over twice the residential baseline population. The Fire Marshal and fire inspector staff perform plan checks and other such functions to maintain the safety of buildings, as well as certain special events.

Office of Emergency Services

The City of Palo Alto's Office of Emergency Services (OES) has a mission to prevent, prepare for and mitigate, respond to, and recover from all hazards. The powers of OES are enumerated in the Palo Alto Municipal Code Section PAMC 2.12.050(b): "(4)Direct coordination and cooperation of services and staff of the emergency organization of the city, and resolve questions of authority and responsibility that may arise between them; and (5)Represent the city in all dealings with public or private agencies on matters pertaining to emergencies as defined herein." Therefore, OES leads or coordinates day-to-day planning, intelligence, and coordination, not only internally but also with allied agencies, Stanford University, the private sector, and the community. OES is responsible for numerous critical assets, including the Emergency Operations Center (EOC) located in the Police Department, the Mobile Emergency Operations Center (MEOC), various interoperability systems, and other equipment.

Police Department

The Palo Alto Police Department, in addition to providing law enforcement services, is responsible for maintaining a core asset for emergency operations: the 911 Communications Center, which provides dispatch for Palo Alto Police Department, the Stanford Department Public Safety (DPS) police, the Palo Alto Fire Department, as well as other government channels. This center serves as the 911 Public

Safety Answering Point (PSAP) for the Palo Alto and Stanford communities. The City's Animal Shelter and Animal Services operation is also a division of the Police Department.

Public Works Department

The Public Works Department is responsible for the approval, construction, maintenance and management of Palo Alto's public facilities, streets, sidewalks, street trees; parking lots and storm drains. The Public Works Department is also responsible for the administration and operation of the Palo Alto Regional Water Quality Control Plant; and administration of the National Flood Insurance Program. In addition, Public Works maintains the entire City fleet with full equipment replacement, preventative maintenance and fueling at the Municipal Service Center, a facility located in the Baylands. The Public Works Department also manages the Palo Alto Airport, also located in the Baylands. The Airport is a critical asset for emergency operations, including day-to-day public safety (for example, it is where the Stanford Life Light rescue helicopter refuels and is maintained). The Civil Air Patrol also has a squadron at the Palo Alto Airport.

Utilities Department

The Utilities Department is responsible for the approval, construction, maintenance and management of Palo Alto's public electric, fiber, water, gas, and wastewater collection facilities. The Utilities Department is also responsible for the maintenance and operation of the street light and traffic signal programs. In addition to having the responsibility for the infrastructure, the Utilities Department purchases all of the water, gas and electricity commodities used within the City.

Information Technology (IT) Department

The IT Department is responsible for data integrity and reliability of information systems that support the functioning of the City and its response to emergencies. The Department bases its information management on three tiers of criticality assigned to the City's systems (e.g., fire protection) that serve the community. Data and operational software for most of the City's systems is currently being moved from on-site computers to a cloud-based system, making it less vulnerable to local physical hazards. The exception is the City's natural gas and electric systems.

City of Palo Alto 2010 Urban Water Management Plan (UWMP)[20]

The California Urban Water Management Planning Act requires every urban water supplier (of a certain minimum size) to prepare and adopt an urban water management plan (UWMP) for the purpose of "actively pursue[ing] the efficient use of available supplies," and stipulates required contents of UWMPs. UWMPs must describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable.

Since 1937, the City has depended on water supplied by the City and County of San Francisco's Regional Water System (RWS) operated by the SFPUC. The RWS is supplied predominantly by watersheds in the Sierra Nevada mountains, while local watersheds and treatment facilities in Alameda and San Mateo Counties supplement the system. On average, SFPUC's Hetch Hetchy Project (see Figure 4.2) provides over 85% of the water delivered to the SFPUC service area. The reliability of the SFPUC water supply is very dependent on reservoir storage. During period of drought, reservoir storage is critical because it enables the SFPUC to carry over water supply from wet years to dry years. During droughts the water received from the Hetch Hetchy system can amount to over 93% of the total water delivered.

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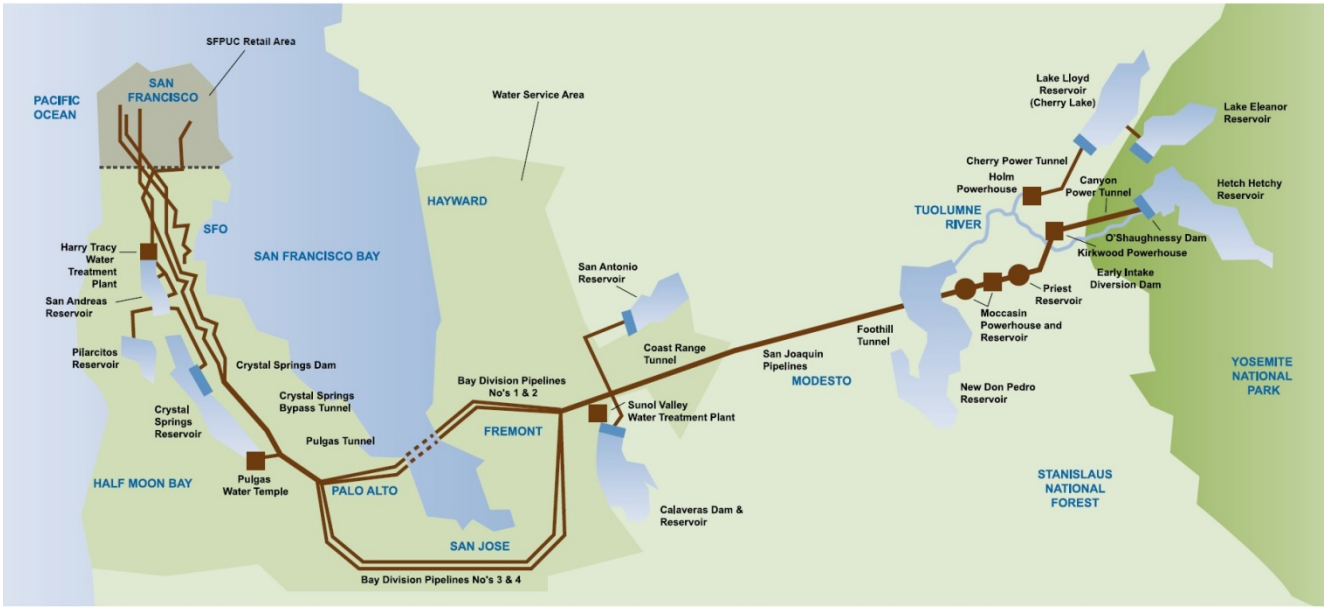
[20] City of Pal Alto Utilities, June 2011: *2010 Urban Water Management Plan*. Available at: http://www.cityofpaloalto.org/gov/depts/utl/eng/water/watermgmt.asp

To assure the long-term adequacy of its water system, the SFPUC is currently undertaking the Water System Improvement Program (WSIP). The WSIP is a $4.6 billion, multi-year, capital program to upgrade the RWS. The program will deliver improvements that enhance the SFPUC's ability to provide reliable, affordable, high-quality drinking water to its wholesale customers and retail customers in an environmentally sustainable manner. The SFPUC developed WSIP water supply objectives based on RWS supplies forecasted for a conservative "design drought" of 8.5 years.[21]

Figure 4.2: SFPUC Regional Water System



Source: 2010 Urban Water Management Plan for the City and County of San Francisco

City of Palo Alto is a member of the Bay Area Water Supply and Conservation Agency (BAWSCA), whose member agencies receive water from the City and County of San Francisco through a contract that is administered by the SFPUC. The City, working in cooperation with SFPUC and BAWSCA, has completed several studies and reports analyzing weather- and climate-related reliability of the water supply. The UWMP summarizes the following studies:

Water Wells, Regional Storage and Distribution System Study (1999) – This study examined the ability of the City's water system to supply water during an 8-hour disruption of SFPUC supply. The study concluded the City should invest in certain capital projects. These projects became part of the City's Emergency Water Supply and Storage Project, which is currently complete.

The Water Supply Master Plan (WSMP, 2000) – The WSMP was a joint study by BAWSCA and the SFPUC to address the future water supply needs of the 30 agencies and 2.3 million people who are served via the SFPUC water system. The City was actively involved in the development of this plan, participating on the WSMP Steering Committee.

[21] The San Francisco Public Utilities Commission, *2013 Water Availability Study for the City and County of San Francisco*, March 2013

Alternative Emergency Water Supply Options Study (2001) – This study examined the ability of the City's distribution system to supply water during various lengths of supply disruption (e.g., 1 day, 3 days, 30 days) and included an analysis of the vulnerability of the City's water distribution system. The study concluded that the capital projects in the Emergency Water Supply and Storage Project, specifically related to groundwater wells, would result in the ability to supply sufficient water in disruptions of SFPUC supply.

Water Integrated Resource Plan (WIRP, 2003) – The WIRP evaluated all the City's water supply alternatives in an effort to determine what long-term direction the City should take for water resource planning. In 2000, this effort resulted in the publication of a document describing in detail all the identified alternatives. The WIRP concludes, based on available information, that supplies from the SFPUC are adequate in normal years, but additional supplies are needed in drought years to avoid shortages.

City of Palo Alto Emergency Water Supply & Storage Project Final Environmental Impact Report (2007) – The City certified the EIR to locate a site and construct a 2.5 million gallon underground water reservoir and pump station in Palo Alto to meet emergency water supply and storage needs. In addition to this water reservoir, the project includes the siting and construction of several emergency supply wells and the upgrade of five existing wells and the existing Mayfield Pump Station. The Emergency Water Supply and Storage Project has been completed.

Recycled Water Facility Plan (March 2009) – This study defined the recycled water alternatives and identified a recommended project alignment. The study also provided a funding strategy and an implementation plan for the recommended project.

Water Conservation Implementation Plan (WCIP, 2009) - The goal of the WCIP is to develop an implementation plan for BAWSCA and its member agencies to attain the water efficiency goals that the agencies committed to in 2004 as part of the Program EIR for the WSIP. At that time, over 32 water conservation measures were evaluated. The WCIP identifies how BAWSCA member agencies can use water conservation as a way to continue to provide reliable water supplies to their customers through 2018 given the SFPUC's Interim Supply Limitation (See *Water Supply Agreement* in next section).

Local Water Use

Total water purchases by CPAU in FY 2014 amounted to 12,673 acre-feet (AF), about equal to FY 2013 sales. Water consumption in FY 2014 was significantly lower than the 1987 (pre-drought) usage. The reduction in present water consumption, compared to pre-drought levels, appears to be the result of several factors, including permanent water conservation measures implemented during the past 30 years and increased standards for water efficient appliances.

The UWMP reports that overall water use in the community decreased by 27% during the period 2000 to 2010. All customer classes showed a significant reduction in annual water use per account. During this period, water use per account decreased by 46% for industrial customers, by 32% for commercial customers, by 12% for public facilities, and by 35% for City facilities. 2010 total water use by single-family residential customers decreased by 22% and multi-family residential water use decreased by 34%.

The UWMP states that the City's water consumption is forecast to remain relatively stable in the future, with a slight increase due to a rebound in the economy and continued, albeit gradual, increase in population and employment numbers. Future projections are uncertain, but large increases in consumption are unlikely. Without implementation of Demand Management Measure (DMMs), water use would increase by about 29 percent by the end of 2030. This forecast includes an expected 17 percent increase in the total number of accounts. This baseline projection includes anticipated effects

of the plumbing code on overall water use as well as expected ongoing conservation efforts among customers. After incorporating the impact of DMMs, total sales are expected to increase by 17 percent from the period 2010 to 2030.

Water Supply Agreement

As a wholesale customer of the SFPUC, the City is bound by the 2009 Water Supply Agreement (WSA) and Individual Water Sales Contract with the SFPUC which has a 25-year term. The WSA provides a "Supply Assurance" of 184 million gallons per day (MGD) to be shared among its wholesale customers that is subject to reduction in cases of water shortage due to drought, emergencies, or malfunctioning/ rehabilitation of the RWS. Under the WSA, the City of Palo Alto has an Individual Supply Guarantee (ISG) of 17.07 million gallons per day (MGD). The WSA includes a Water Shortage Allocation Plan that addresses shortages of up to 20% of system-wide use, through pre-set allocations to its wholesale customers. The Tier 1 plan addresses how the available water supplies would be divided between San Francisco and its wholesale customers. The Tier 2 plan, developed in 2010 by BAWSCA agencies, was approved by all participating agencies including Palo Alto. It addresses how the water available to the wholesale customers would be divided among them. The Tier 2 Water Shortage Implementation Plan is in effect until 2018, when SFPUC must re-evaluate the Supply Assurance.

In addition to the WCIP described above, BAWSCA and its member agencies identified five additional water conservation measures, which, if implemented fully throughout the BAWSCA service area, could potentially save an additional 8.4 MGD by 2018 and 12.5 MGD by 2030. The demand projections for the BAWSCA member agencies, as transmitted to the SFPUC on June 30, 2010, indicate that collective purchases from the SFPUC will stay below the 184 MGD allocation through 2018 as a result of revised water demand projections, the identified water conservation savings, and other actions.

When SFPUC adopted the WSIP, it approved an interim water supply limitation through 2018, when it expects it will be in a better position to make decisions regarding long term water supply issues. Palo Alto's Interim Supply Allocation (ISA) is 14.70 MGD. The UWMP does not anticipate exceeding the 14.70 MGD ISL during the ISL period ending in 2018.

The ISA is distinct from the ISG. The ISG is a perpetual entitlement for water delivered from the SFPUC system that survives the expiration of the current water delivery contract. The ISA is an interim water delivery limitation intended to accomplish the goals outlined in the adopted WSIP, and it automatically expires in 2018.

Climate Change section of the UWMP

The UWMP recognizes the importance of climate change in water resources planning. The following passage, extracted from the City's 2010 UWMP, indicates that the SFPUC is monitoring the effects of climate change on its water supply and as recently as 2009 did not consider supply to be at significant risk through the year 2030:

As described by the SFPUC in its October 2009 Final Water Supply Availability Study for the City and County of San Francisco, there is evidence that increasing concentrations of greenhouse gasses have caused and will continue to cause a rise in temperatures around the world that could result in a wide range of changes in climate patterns. These changes are expected to have a direct effect on water resources in California. Climate change could result in the following types of water resource impacts, including impacts on the watersheds in the Bay Area:

- Reductions in the average annual snowpack due to a rise in the snowline and a shallower snowpack in the low and medium elevation zones, such as in the Tuolumne River basin, and a shift in snowmelt runoff to earlier in the year;
- Changes in the timing, intensity and variability of precipitation, and an increased amount of precipitation falling as rain instead of as snow;
- Long-term changes in watershed vegetation and increased incidence of wildfires that could affect water quality;
- Sea level rise and an increase in saltwater intrusion;
- Increased water temperatures with accompanying potential adverse effects on some fisheries and water quality;
- Increases in evaporation and concomitant increased irrigation need; and
- Changes in urban and agricultural water demand.

According to the SFPUC'S October 2009 study, other than the general trends listed above, there is no clear scientific consensus on exactly how climate change will quantitatively affect the state's water supplies, and current models of water systems in California generally do not reflect the potential effects of climate change.

Initial climate change modeling completed by the SFPUC indicates that about seven percent of runoff currently draining into Hetch Hetchy Reservoir will shift from the spring and summer seasons to the fall and winter seasons in the Hetch Hetchy basin by 2025. This percentage is within the current interannual variation in runoff and is within the range accounted for during normal runoff forecasting and existing reservoir management practices. The predicted shift in runoff timing is similar to the results found by other researchers modeling water resource impacts in the Sierra Nevada due to warming trends associated with climate change.

The SFPUC has stated that based on this preliminary analysis, the potential impacts of climate change are not expected to affect the water supply available from the San Francisco Regional Water System (RWS) or the overall operation of the RWS through 2030.

The SFPUC views assessment of the effects of climate change as an ongoing project requiring regular updating to reflect improvements in climate science, atmospheric/ocean modeling, and human response to the threat of greenhouse gas emissions. To refine its climate change analysis and expand the range of climate parameters being evaluated, as well as expand the timeframes being considered, the SFPUC is currently undertaking two additional studies. The first utilizes a newly calibrated hydrologic model of the Hetch Hetchy watershed to explore sensitivities of inflow to different climate change scenarios involving changes in air temperature and precipitation. The second study will seek to utilize state-of-the-art climate modeling techniques in conjunction with water system modeling tools to more fully explore potential effects of climate change on the SFPUC water system as a whole. Both analyses will consider potential effects through the year 2100. It is now known when these studies will be completed, but SFPUC's 2015 update of its UWMP should provide additional information.

Drought Planning

October 1, 2011 to September 30, 2014 was the driest three-year period on hydrologic record in California and as a result, reservoir storage, snowpack, and reservoir inflows were significantly lower than normal throughout the State. The unprecedented dry weather conditions prompted Governor Jerry Brown to declare a drought emergency for the State of California in January 2014. This action

spurred the SFPUC to request that all customers of the Regional Water System voluntarily reduce water use by at least 10%.[22]

When the City's 2010 UWMP was completed, the City had experienced severe droughts during 1976-77 and 1987-93. In response to these droughts the City adopted a number of water conservation strategies. Following the conclusions in the 2003 WIRP that supplies from the SFPUC could be inadequate during drought years, the City adopted a set of guidelines in 2003 seeking to reduce the potential supply deficit. The options considered include using groundwater, connecting to the SCVWD's treated water pipeline, developing recycled water, and expanding water efficiency programs.

Following the WIRP a public survey was conducted, and based on conclusions from the survey and the WIRP, City staff in 2004 made the following 5 recommendations:

1. Installation of advanced treatment systems for groundwater is too expensive, both in capital and in operating costs.

2. Blending at an SFPUC turnout is the best way to use groundwater as a supplemental drought time supply while maintaining good water quality.

3. In the selection process for new well sites, the costs for blending with SFPUC water in droughts should be considered. The least expensive location is a well at El Camino Park due to its proximity to an SFPUC turnout.

4. Actively participate in the development of long-term drought supply plans with SFPUC and BAWSCA.

5. Continue in the efforts identified in the Council-approved WIRP Guidelines:

    - Evaluate a range of demand-side management (DSM) options for their ability to reduce long-term water demands;

    - Evaluate feasibility of expanding the use of recycled water; and

    - Maintain emergency water conservation measures to be activated in case of droughts.

Conservation Measures

At its core, the UWMP is essentially a plan to comply with the Water Conservation Bill of 2009 (SBx7 - 7), enacted in November 2009, which requires water suppliers to reduce the statewide average per capita daily water consumption by 20% by December 31, 2020. Palo Alto's 2020 target is 179.3 gallons per capita, a 20% reduction from a baseline of 223 (average calculated over 10 year period from 1995-2004).

At minimum, an UWMP must evaluate fourteen Demand Management Measure (DMMs) identified in the Urban Water Management Planning Act. The following DMMS are currently implemented or are planned for future implementation by the City. The 2010 UWMP evaluates each of them in detail for goals, cost-effectiveness, and conservation savings:

A. Water Survey Programs for Single-Family and Multi-Family Residential Customers

[22] ibid

B. Residential Plumbing Retrofit

C. System Water Audits, Leak Detection, and Repair

D. Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections

E. Large Landscape Conservation Programs and Incentives

- Landscape Survey Program for Commercial, Industrial, Institutional Customers
- Weather - Based (Evapotranspiration) Irrigation Controller Rebates
- Large Landscape Turf Replacement
- Residential Turf Replacement
- Landscape Rebates for Irrigation Hardware Upgrades

F. High - Efficiency Washing Machine Rebate Programs

G. Public Information Programs

H. School Education Programs

I. Conservation Programs for Commercial, Industrial, and Institutional (CII) Accounts

- Commercial Water Audits
- Water Efficiency Direct Installation Program
- Water Efficient Technologies Rebate Program
- CII High Efficiency Toilet Direct Installation Program

J. Conservation Pricing

K. Water Conservation Coordinator

L. Water Waste Prohibition

M. Residential Ultra - Low - Flush Toilet Replacement

N. New Development Indoor and Outdoor Regulations

O. Irrigation Classes for Homeowners

P. Rainwater Harvesting Incentives

Q. Residential Graywater Reuse

The City is currently operating or is in the process of launching several new conservation programs with particular emphasis on outdoor irrigation efficiency including high water use landscape conversion, and improved efficiency measures for the commercial, industrial, and institutional sectors. Additionally, the use of graywater reuse, rainwater harvesting systems, and other water efficiency measures may be evaluated further for conservation potential leading up to the 2015 UWMP. The City is committed to promoting all cost-effective conservation programs that meet both the City's water

reduction goals and community interest. Palo Alto shifts emphasis between different conservation programs depending on various factors, including community acceptance. Over time, the program mixture may change, though the overall savings goals will remain constant.

Local Groundwater Supply

The quality of the City's groundwater is considered fair to good[23], having recovered from past overdrafts, and the City has an existing water well system consisting of eight deep aquifer wells (not hydrologically connected to surface groundwater) with a combined total rated capacity of approximately 11,300 gallons per minute (gpm). Some of these wells have been called into service in the past (1988 and 1991) when the City faced shortages due to SFPUC implemented mandatory rationing. The Santa Clara Valley Water District (SCVWD) is the groundwater management agency in Santa Clara County; the groundwater basin is not adjudicated, meaning water rights have not specifically been established by the courts to determine who can pump groundwater, how much groundwater can be pumped, and how the process is managed.

As of the 2010 UWMP writing, no decision had been made regarding whether or not to use groundwater as a supplemental supply in droughts, though the City has completed the Emergency Water Supply and Storage Project which provides the City the flexibility to rely on groundwater during a drought if necessary. The project consists of the repair and rehabilitation of the five existing wells, construction of three new wells, potentially equipping one well for use as a supplemental water supply, construction of a new 2.5 million gallon underground storage reservoir at El Camino Park and associated pump station, and other upgrades to the groundwater supply system. If the wells were to be used as a dry year supplemental supply source, the City would use the new well at El Camino Park and blend the groundwater with SFPUC supplies to meet regulatory standards for drinking water quality. In addition, several other issues will need to be addressed prior to the use of the wells during a drought, including issues of water quality compared to the City's SFPUC source, customer acceptance, and SCVWD groundwater production costs.

The Emergency Water Supply and Storage Project's primary goal is to provide water supply in the case of fire, or drought emergency, or loss of SFPUC supplies due to earthquake or other disaster. The completed project provides a minimum of eight hours of normal water use at the maximum day demand level and four hours of fire suppression at the design fire duration level. The groundwater system may also be used to a limited extent for water supply during drought conditions (up to 1,500 acre feet per year), and is capable of providing normal wintertime supply needs during extended shutdowns of the SFPUC system. The project provides up to 11,000 gpm of reliable well capacity and 2.5 million gallons (MG) of water storage for emergency use.

Transfer or Exchange Opportunities

Because the existing RWS does not have sufficient supplies in dry years, dry-year water transfers are potentially an important part of future water supplies. In addition to the WSMP and the WSIP described above, the City is monitoring the development of a water transfer market in California, including a mechanism for BAWSCA members to transfer contractual entitlements on the SFPUC system. The City supports SFPUC's efforts to pursue cost-effective dry-year water transfers as part of

[23] The City's groundwater is approximately six times higher in total dissolved solids (TDS) and hardness compared to SFPUC-supplied water.

the overall water supply for the RWS. BAWSCA has the ability to pursue water transfers on its own as long as a wheeling arrangement can be negotiated with the SFPUC.

Recycled Water

The City operates the Regional Water Quality Control Plant (RWQCP), a wastewater treatment plant, for the East Palo Alto Sanitary District, Los Altos, Los Altos Hills, Mountain View, Palo Alto, and Stanford University. Wastewater from these communities is treated by the RWQCP prior to discharge to the Bay. The UWMP provides a thorough assessment of recycled water as a water source for the City, noting that the quality of the water discharged from the RWQCP meets very high standards and approaches the standards for drinking water.

The 2010 UWMP summarizes the extensive planning work the City has conducted related to recycled water, starting with the Water Reclamation Master Plan co-authored with other RWQCP partners in 1992, a Recycled Water Market Survey in 2006, and a Recycled Water Facility Plan in 2008. The latter study recommended the Palo Alto Recycled Water Project,[24] which proposes the construction of a recycled water pipeline and associated facilities to provide an alternative water supply for non-potable uses. The proposed project, now being implemented in phases, involves the construction of approximately five miles of 12- to 18-inch pipes, a booster pump station and a pump station at the RWQCP, and approximately five miles of lateral pipelines to over 50 use sites. The project is envisioned to serve approximately 900 acre-feet per year of recycled water[25], mostly to the Stanford Research Park Area. The predominant use of recycled water for this project is landscape irrigation. Some industrial use, such as commercial and light industrial cooling towers, could also be included at a later date.

The City is a stakeholder in multiple regional recycled water planning groups and initiatives, including the California Water Reuse Association, the Bay Area Recycled Water Coalition, SCVWD Recycled Water Committee, the Bay Area Clean Water Agencies Recycled Water Committee, and the ABAG-led effort to secure grant funding for the Bay Area Integrated Regional Water Management Plan (IRWMP) and related projects.

In September 2010, the RWQCP completed installation of a new ultraviolet disinfection facility which will allow a gradual increase in the amount of recycled water that meets the Title 22 unrestricted use standard if demand requires an upgrade to the recycled water storage capacity. The remaining treated wastewater meets the restricted use standard and can also be recycled.

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[24] The Utilities and Service Systems Element of the City's 2014 Draft Comprehensive Plan provides an up-to- date assessment of the Recycled Water Project, noting that the majority of the wastewater treated at the RWQCP could be recycled and that the plant already has some capability to produce recycled water that meets the Title 22 unrestricted use standard (approximately 4.5 MGD of capacity of which 4.5 MGD is presently available). The Recycled Water Project is currently serving non-potable needs in areas east of Highway 101, including irrigation at the golf course and Greer Park, marsh enhancement at Emily Renzel Marsh, and various needs at the Municipal Service Center and RWQCP.

[25] Since the 2010 UWMP, elevated salinity levels in the recycled water have been identified as an area of concern to the project's stakeholders. The City has approved a Salinity Reduction Policy outlining steps to lower the TDS levels in the recycled water towards the goal of increased customer acceptance of the use of recycled water. Recently completed salinity control measures have proven successful and the Total Dissolved Solids (TDS) has been reduced from 920 mg/L (2009-2012 Average) to 770 mg/L (2013 average). Additional projects are underway and further reductions are anticipated.

Desalinated Water

The UWMP notes that the City has no plans for development of desalinated water. It is possible a desalination facility may be part of a preferred supply portfolio identified in the BAWSCA Long Term Reliable Water Supply Strategy. The City is currently aware of one regional collaborative effort between different water agencies to evaluate a large scale Bay Area desalination project, The Bay Area Regional Desalination Project. The Bay Area Regional Desalination Project is a collaboration between the East Bay Municipal Utility District, SCVWD, the SFPUC, Contra Costa Water District, and Zone 7 Water Agency to jointly explore developing the feasibility of a regional desalination facility that could directly or indirectly benefit 5.4 million San Francisco Bay Area residents and businesses served by these agencies.

Strategy to Advance Flood Protection, Ecosystems, and Recreation Along the Bay (SAFER Bay)

The existing coastal levees along Palo Alto's San Francisco Bay shoreline are too low to provide FEMA-certified flood protection to Palo Alto and its neighbors. The existing levees do not meet current state and federal standards. Therefore, the Palo Alto has joined with other member communities in the San Francisco Creek Joint Powers Authority (SFCJPA) to plan and design coastal flood management. This project is known as Strategy to Advance Flood Protection, Ecosystems, and Recreation Along the Bay (SAFER Bay). This project started in December 2014, with planning to continue through 2015.

The SAFER Bay project will reduce the risk of flooding within the study area from San Francisco Bay coastal waters and support the communities' desire to be removed from the FEMA floodplain. At a minimum, the project will accommodate the current FEMA 100-year still water elevation plus freeboard. Where feasible, current FEMA 100-year plus freeboard plus 3 feet of future sea level rise will be provided. This accommodation for 3 feet of sea level rise will match the design criteria of another SFCJPA project to improve the levees along the lower, tidal portion of San Francisquito Creek. In addition, the project will also:

- expand opportunities for improved recreation and community connectivity;
- minimize future maintenance requirements;
- incorporate features that facilitate adaptation to our changing climate by utilizing tidal marsh areas for flood protection in a way that enhances habitat and facilitates restoration associated with the South Bay Salt Ponds Restoration Project; and
- create opportunities for partnership with agencies and organizations pursuing similar objectives.

In relation to the last bullet, Palo Alto is also coordinating with the City of Mountain View to coordinate coastal flood management along these cities' shared boundary.

Bay Area Integrated Regional Water Management Plan (IRWMP)[26]

The Bay Area IRWMP presents a thorough summary of climate change projections and expected impacts to four water-related Functional Areas in the Bay Area, including water supply/water quality, flood control wastewater/stormwater, and watershed and habitat protection.

[26] San Francisco Bay Area Integrated Regional Water Management Plan, September 2013. Available at: http://bairwmp.org/

The Bay Area IRWMP reviewed climate change adaptation strategies from a wide range of regional and local initiatives and planning documents such as urban water management plans, habitat restoration plans, wastewater treatment master plans, watershed stewardship plans and water supply strategies.

Table 4-1 identifies climate change adaptation strategies identified by the IRWMP that are included in representative regional and local plans according to corresponding Functional Areas and vulnerabilities and priorities. The IRWMP reviewed plans affecting all Functional Areas and sub regions. The review confirmed that, with the exception of urban water supply, the approach to water resources planning in general varies widely across Functional Areas and among agencies. For example, with respect to sea level rise and vulnerable water resources infrastructure (e.g., wastewater treatment plants), not all local plans reviewed contained adaptation strategies. This may reflect the absence of a legal requirement for a plan rather than a lack of planning for sea level rise; some agency websites indicated that climate change planning was indeed underway.

Adaptation Strategies Identified In Bay Area IRWMP

The Bay Area IRWMP identifies the following general strategies for adapting to climate change:

- Incorporate climate change adaptation into relevant local and regional plans and projects;
- “No Regrets” approach to address immediate or ongoing concerns while reducing future risks;
- Establish a climate change adaptation public outreach and education program;
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation strategy development and regional approaches;
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness; and
- Update building codes and zoning.

Additional strategies identified in Bay Area local plans for adapting to water supply impact include local capture and reuse projects, and desalination.

Table 4-1: Bay Area Adaptation Strategies Identified in the Bay Area IRWMP[27]

Vulnerability	Areas/Functions Affected	Strategies
Sea Level Rise & Coastal Flooding	• Low-lying Baylands increasingly vulnerable to more frequent, longer, deeper flooding • Critical infrastructure in the hazard zone, includes wastewater treatment plants power plants vulnerable to 100-year coastal flood	• Multifunctional ecosystem-based adaptation along the bayshore and rivers • Remove critical infrastructure from hazard zone • Raise, armor and maintain flood control structures that protect critical infrastructure that cannot be moved. • Prevent placement of new infrastructure in areas likely to be inundated. • Improve emergency preparedness, response, evacuation and recovery plans.
Fluvial Flooding	• More intense storms leading to more frequent, longer, deeper flooding generally expected	
Hydropower	• Decrease in Sierra snowpack is expected; increased evapotranspiration is expected; shift in timing of runoff virtually certain; and timing and amount of power generation is expected to change	
Water Supply	• Decrease in total precipitation is possible; • Delta Sources – impacts from sea level rise • Regional Sources – continued variability in precipitation; potentially less spring precipitation; more intense storms may affect surface water runoff, storage, groundwater recharge.	• Continued water conservation including water efficient landscaping programs • Reduce reliance on imported water • Increased use of recycled water • Improve potential movement of water supplies among neighbouring agencies during periods of extreme water

[27] Based on Table 12-3 in the Bay Area IRWMP

	• Demand likely to increase due to increases in air temperature, increased evaporation losses and longer growing season	shortage • Expand available water storage • Adopt land use ordinances that protect natural functioning of groundwater recharge areas • Implement tiered pricing to reduce water consumption and demand
Water Quality	• Sierra Nevada Supplies – imported water potentially vulnerable to water quality change • Delta Supplies – increased salinity from sea level rise, increased turbidity from extreme storm events • Regional Supplies – water quality impacts from increased temperature, decreased precipitation, decreased recharge, more intense storms, increased wildfire risk, longer periods of low flow conditions.	• Evaluate capability of surface water treatment plants to respond to extreme storm events and increased risk of wildfires. • Encourage projects that improve water quality of contaminated groundwater sources • Increase implementation of LID techniques to improve stormwater management.
Ecosystem and Habitat	• Changes in temperature and precipitation, together with increased wildfire will result in impacts to species, increased invasive species' ranges, loss of ecosystem functions, changes in growing ranges for vegetation.	• Provide or enhance connected "migration corridors" and linkages between undeveloped areas for animals and plants • Promote water resources management strategies that restore and enhance ecosystem services • Re-establish natural hydrologic connectivity between rivers and floodplains

Silicon Valley 2.0

Silicon Valley 2.0 is a regional planning effort, led by the County of Santa Clara Office of Sustainability, to minimize the anticipated impacts of climate change.[28] The primary goals of the project are to:

- Identify assets threatened by climate change and the magnitude of the potential economic, social, and environmental impacts;
- Identify potential strategies to minimize these impacts;
- Develop a decision-support tool to evaluate potential climate change impacts and community / regional strategies;
- Identify the region's top priorities and the near–term actions to implement an effective regional scale adaptation response; and
- Facilitate and coordinate regional climate adaptation planning and implementation efforts for Silicon Valley.

Silicon Valley 2.0 is assessing five exposure areas of climate change: Sea Level Rise, Coastal Storm Surge, Riverine Flooding, Wildfire, and Extreme Heat. Vulnerability assessments and strategies for adapting to these exposures are organized into nine separate categories of community assets:

- Shoreline protection (dikes and levees)
- Buildings + Properties
- Communications
- Ecosystems
- Energy
- Public Health (including vulnerable populations)
- Solid + Hazardous Waste
- Transportation
- Water + Wastewater

A decision support tool is being developed as part of the Silicon 2.0 project, which will allow local governments in Santa Clara County to assess vulnerabilities and potential economic impacts of climate change within their communities. The tool (see Figure 4.3) , which should be available in 2015, will identify assets that will be exposed to climate change variables, estimates level of economic consequence resulting from asset vulnerability, and allow users to select and prepare vulnerability and risk reports. This project should provide the City of Palo Alto with a valuable resource for adaptation planning going forward.

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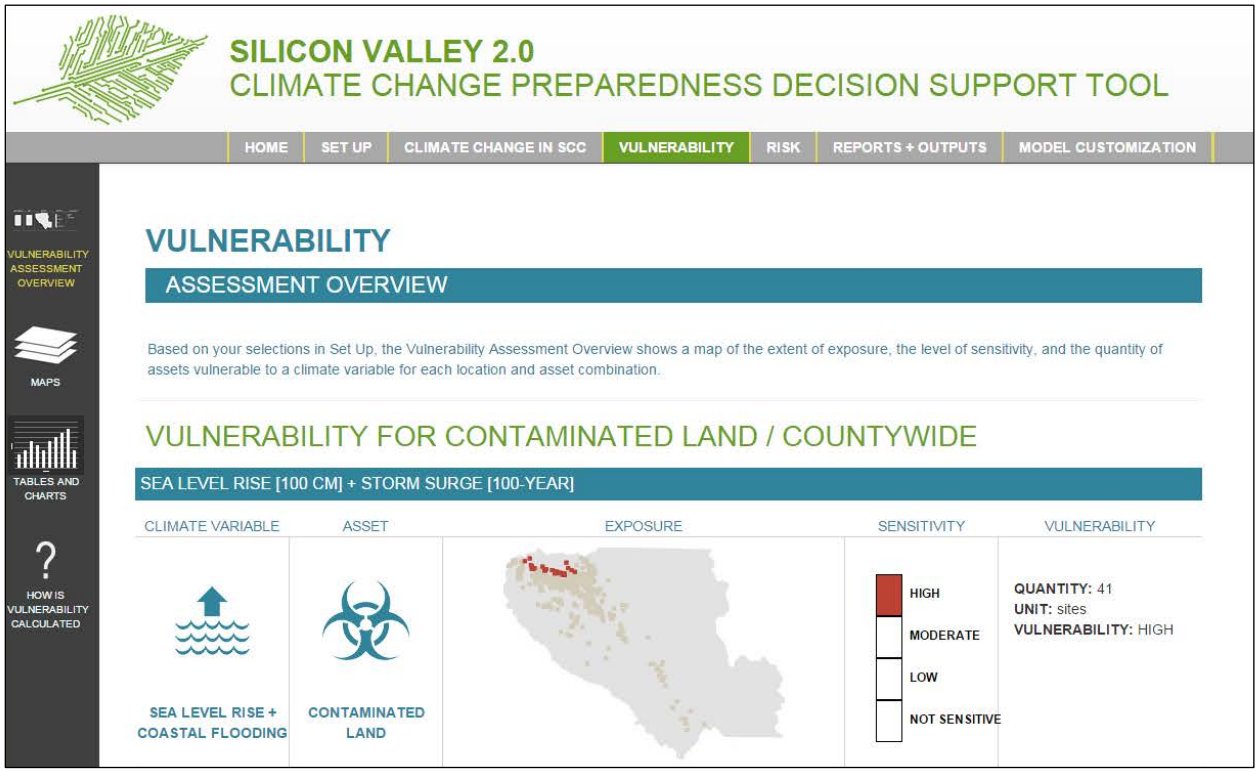
[28] Santa Clara County Office of Sustainability, *Silicon Valley 2.0 Climate Adaptation Guidebook*, Administrative Draft, December 2, 2014.

Figure 4.3: Silicon Valley 2.0 Tool Screen Shot: Vulnerability Assessment Overview



Living with a Rising Bay (2011)[29]

In 2011, the San Francisco Bay Conservation and Development Commission (BCDC) prepared this shoreline vulnerability assessment to help local and regional government agencies and the public understand how existing planning and management challenges will be exacerbated by climate change and to assist in developing strategies for dealing with these challenges. The assessment focused on shoreline development, the Bay ecosystem, and governance. The report provided the basis for a subsequent amendment to the Bay Plan specifically addressing sea level rise. While the report acknowledged the limitations of BCDC's regulatory authority to ensure that sea rise is taken into consideration in project planning, it also identified a number of strategies that the agency and others can undertake to address issues identified in its vulnerability assessment. These are summarized in Table 12-4 of the Bay Area IRWMP, and summarized in Table 4-2 below.

[29] San Francisco Bay Conservation and Development Commission (BCDC), 2011*: Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline.* Available at: http://www.bcdc.ca.gov/

Table 4-2: Summary of Sea Level Rise Adaptation Strategies Identified by BCDC

Shoreline Development	
General Strategies	• **Conduct risk assessments** for shoreline areas and larger shoreline projects. • **Design for the Long-Term**. Design projects to be resilient to a mid-century sea level rise projection and adaptable to longer-term impacts. • **Consider Impacts.** Build projects that do not negatively impact the Bay and do not increase risks to public safety, or if projects do increase flood risks, ensure that regional public benefits outweigh the increased risk of flooding. • **Incorporate Flood Protection.** Protect new projects from future storm activity and sea level rise by using setbacks, elevating structures, designing structures that tolerate flooding or other effective measures. • **Avoid Filling the Bay.** Set aside land on the upland side of levees to allow for future levee widening to support additional levee height so that no fill is placed in the Bay. • **Preserve Public Access.** Design and construct shoreline protection to avoid blocking physical and visual public access.
Public Access Strategies	• **Design to Avoid Impacts.** Site, design, manage and maintain public access to avoid significant adverse impacts from sea level rise and shoreline flooding. • **Accommodate Future Conditions.** Design any public access to remain viable in the event of future sea level rise or flooding, or provide equivalent access to be provided nearby.
Bay Ecosystem	
General Strategies	• **Preserve Sensitive Habitat.** Preserve and enhance habitat in undeveloped areas that are both vulnerable to future flooding and have current or potential value for important species. • **Incorporate Habitat into Shoreline Protection Design.** Design shoreline protection projects to include provisions for establishing marsh and transitional upland vegetation as part of the protective structure, wherever feasible. • **Include Buffers.** Include a buffer, where feasible, between shoreline development and habitats to protect wildlife and provide space for marsh migration as sea level rises.
Research and Planning	• **Conduct Research and Monitoring.** Conduct comprehensive Bay sediment research and monitoring to understand sediment processes necessary to sustain and restore wetlands. • **Update Targets to Accommodate Climate Change.** Update regional habitat conservation and restoration targets to achieve a Bay ecosystem resilient to

	climate change and sea level rise.
Governance	
Regional Conservation Strategy	• **Adaptive Management.** Develop a regional strategy for conservation and development of the Bay and its shoreline that incorporates adaptive management. • **SB 375.** Ensure that the strategy is consistent with the climate change mitigation goals of SB 375 and the principles of the California Climate Adaptation Strategy. • **Update.** Update the strategy regularly to reflect changing conditions and scientific information.
Mapping	• **Map Vulnerable Areas.** Include maps of shoreline areas that are vulnerable to flooding based on projections of future sea level rise and shoreline flooding. • **Consult Authorities.** Prepare the maps under the direction of a qualified engineer and regularly update them in consultation with government agencies with authority over flood protection
Integration	• **Long-Term Planning.** Identify and encourage the development of long-term regional flood protection strategies that may be beyond the fiscal resources of individual local agencies. • **Incorporate Multiple Agencies.** Develop a framework for integrating the adaptation responses of multiple government agencies. • **Integrate with Local Processes.** Provide information, tools, and financial resources to help local governments integrate regional climate change adaptation planning into local community design processes. • **Environmental Justice.** Address environmental justice and social equity issues. • **Hazards and Emergencies.** Integrate hazard mitigation and emergency preparedness planning with adaptation planning.

Adapting to Rising Tides (ART)[30]

ART is a collaborative planning effort, led by the San Francisco Bay Conservation and Development Commission (BCDC) and the NOAA Coastal Services Center, to understand how San Francisco Bay Area communities can adapt to sea level rise and storm event flooding. The ART Project has engaged local, regional, state and federal agencies, as well as non-profit and private stakeholders, to

[30] San Francisco Bay Conservation and Development Commission (BCDC) and the NOAA Coastal Services Center, 2011: Adapting to Rising Tides; project information and resources available at http://www.adaptingtorisingtides.org/

explore how the Bay Area can increase resilience to sea level rise and storm events while protecting critical ecosystem and community services.

The ART pilot project focused on a portion of the Alameda County shoreline, from Emeryville to Union City. The pilot project formed a working group of the subregion's diverse stakeholders, including staff at local, county, regional, state and federal agencies that work in the subregion, as well as some private interests with investments in the study area, to assess the subregion's vulnerability and risk associated with sea level rise and storm events. A portfolio of possible adaptation responses was then developed for the ART subregion, which now serve as starting points for further adaption planning that will need to occur at multiple scales in the region. BCDC and its partners are now transitioning ART from a pilot project to regional program that will provide tools, data, and resources to local communities around the Bay.

The ART pilot project identified many planning issues that are relevant across the Bay region at most planning scales. The ART pilot project report highlights the general need for more high quality data and information to improve the understanding of vulnerability and risk. These information gaps include:

- Limited understanding of how groundwater and salinity levels along the shoreline will respond to a rising Bay.
- Limited understanding of how tidal marshes and managed marshes will respond to sea level rise. There is a lack of information on how these dynamic systems will be affected by changes in the shoreline, and in particular by structural solutions such as levees and berms that can change tide, wave or sediment conditions.
- Limited information on the ownership, location and condition of energy, pipeline, telecommunication, and stormwater infrastructure is particularly difficult to obtain, as it does not currently exist or is not publically available, up-to-date, or easily accessible.
- A lack of centrally coordinated, up-to-date, accurate information about hazardous material sites and contaminated lands is a barrier to planning for future flood risks. Many commercial and industrial land uses generate, treat, store or transport hazardous materials, and a number of shoreline parks in the subregion are built on closed landfills. These types of land uses are particularly vulnerable as flooding could result in a release or mobilization of potentially harmful materials.
- Flood risk maps for many shoreline communities around the Bay that remain outdated or inadequate in terms of predicting future changes due to sea level rise.

The ART pilot project also highlighted the risk to assets that function as interconnected networks, such as highways, rail corridors, utility infrastructure, and systems of shoreline protection along the Bay's edge, where disruption to one segment can cause cascading, secondary impacts to adjacent and distant segments, rendering the entire systems highly vulnerable. Much of the networked infrastructure in the Bay Area is essential to day-to-day community and economic functions, and is critical during an emergency or disaster. These networked systems typically represent myriad stakeholders, jurisdictions, and management systems. It is important for local jurisdictions to understand dependencies on regional networked infrastructure and climate-related vulnerabilities and risks they represent.

Cal-adapt[31]

Following the 2009 publishing of the California Climate Adaptation Strategy, the California Natural Resources Agency in partnership with UC Berkeley's Geospatial Innovation Facility (GIF) and the California Energy Commission's Public Interest Energy Research (PIER) Program developed the Cal-adapt web-based climate adaptation planning tool. Cal-adapt allows planners and other decision makers to identify potential climate change risks in specific geographic areas throughout the state. It synthesizes volumes of existing downscaled climate change scenarios and climate impact research and presents it in an easily available, graphical layout that is intended to benefit local planning efforts. Maps and data can be downloaded in a variety of tabular and GIS formats. Interactive maps and charts are provided for looking changes over time under different GHG emissions scenarios for:

- Temperature: monthly and decadal averages
- Temperature: degrees of change
- Temperature: extreme heat events
- Snowpack: decadal averages
- Precipitation: decadal averages
- Sea Level Rise: threatened areas
- Wildfire: fire risk areas

[31] Cal-adapt web-based climate adaptation planning tool available at: www.cal-adapt.org

Community Assets

Community assets considered in the vulnerability analysis include City-owned or operated facilities deemed critical for operations, utilities, and risk management, and other assets that are important to community health, safety, and well-being. It also includes the residents and businesses of Palo Alto. For a full list of community assets, see Appendix C.

The City's 2010 LHMP identifies 50 critical facilities related to potable water supply, shelter, fire suppression, emergency response, electricity supply, natural gas supply, stormwater management, wastewater treatment, and city administration. The LHMP list provided the starting point for identifying City facilities that are exposed to climate change hazards. Building from that list, this Adaptation Roadmap assesses vulnerabilities in the following eleven functional categories of community assets. Appendix C includes a map showing the locations of these community assets, identified by number and by functional asset category.

Emergency Response and Communications (ER): Facilities that are critical in times of emergencies and natural disasters, including hospitals and other medical facilities, telecommunications infrastructure, cooling centers, police and fire stations, emergency operations centers and evacuation shelters. The City-owned dark fiber optic backbone provides access to key City facilities and offices such as IT Infrastructure Services, electric utility substations, traffic signals, libraries and the Wastewater Treatment Plant. The majority of the City's business parks (e.g. Stanford Research Park) and commercial properties are also passed by the fiber backbone.

Energy Security and Infrastructure (ES): The City's energy supply and supporting infrastructure, including electrical substations and transmission lines, natural gas lines and pumping stations, and emergency generators. Changes in precipitation patterns caused by climate change are expected to directly affect the availability of hydropower for the City, since the city receives a percentage of power generated by the Western Area Power Administration's Central Valley Project and the Calaveras Hydroelectric Project. In addition to the anticipated decline in overall precipitation, the quality and timing of winter precipitation will also impact Palo Alto's power supply.

Water Security and Supply Infrastructure (WS): Natural and manmade water systems for supplying clean, safe and reliable water supply for the City of Palo Alto, including potable water reservoirs, groundwater wells, piping systems, pumping stations, turnouts, and water treatment infrastructure. As described in the UWMP, the City of Palo Alto receives 100% of its water supply from the City and County of San Francisco's Regional Water System (RWS), operated by the SFPUC, which is supplied 85% on average from distant Sierra Nevada mountain watersheds. Palo Alto's water utility operations and dispatch of service vehicles are centralized at the Palo Alto Municipal Services.

Wastewater Management (WW): Palo Alto's wastewater collection and treatment infrastructure including the Regional Water Quality Control Plant (RWQCP) operations, approximately 208 miles of sewer lines, and treated effluent outfalls. Wastewater operations and service vehicles are centralized at the Palo Alto Municipal Services Center.

Stormwater Management (SW): Palo Alto's stormwater management system is designed to convey the 10-year return 6-hour storm event. The system consists of approximately 107 miles of pipeline and 2,750 catch basins, 800 manholes and 6 pump stations. This infrastructure conveys runoff into one of four local creeks: San Francisquito Creek, Matadero Creek, Barron Creek, or Adobe Creek. San Franciscquito Creek drains unimpeded into San Francisco Bay. The other three creeks drain into the Palo Alto Flood Basin (PAFB) before draining to the Bay.

The PAFB (for location, see Appendix C), constructed in 1956, provides flood management for the City, as well as providing wildlife habitat. The PAFB consists of levees surrounding a 600-acre portion

of the Palo Alto Baylands that extends east-northeast from Highway 101. By preventing tides from inundating the Flood Basin, the levees provide storage capacity for creek discharge and reduce the City's coastal flood risk. The Basin receives inflow from Matadero Creek, Adobe Creek, Barron Creek, and the City of Mountain View's Coast Casey Storm Water Pumping Station. The Basin can store discharges from these sources and release them to San Francisco Bay through tide gates when the water level in the Basin is higher than the Bay water level. The tide gates are controlled by the Santa Clara Valley Water District. The Basin has the capacity to retain several hours of high creek discharge while waiting for a low tide when stored flood waters can be released to the Bay. Starting in 1973, the tide gates were modified to enable a muted tidal influence while preserving water levels in the Basin close to the Bay's low tide level. Since that time, the basin has been designated as a tidal wetlands nature preserve by the City, providing critical habitat protection for tidal marsh wildlife.

Palo Alto's stormwater operations and dispatch of service vehicles are centralized at the Palo Alto Municipal Services Center.

Transportation Infrastructure (TI): Critical roads, and bridges, and other transportation infrastructure including the Palo Alto Airport. Operational control of the Palo Alto Airport was recently transferred to the City from Santa Clara County. Though the LHMP does not encompass critical transportation infrastructure assets, the OES recognizes both the airport and two Highway 101 overpasses (San Antonio Road and Oregon/Embarcadero Road) as potential critical points of failure in an emergency because they provide a transportation link between many of the City's critical facilities (e.g., emergency response vehicles and operations for the Departments of Public Works and Utilities) and the bulk of the City's population, which reside on opposite sides of U.S. 101.

Shoreline Flood Management (SF): Currently, much of Palo Alto's shoreline is exposed to coastal flood hazard, as indicated by FEMA's mapping of the 1% annual chance floodplain (Figure 6.6). Although the existing levees provide some degree of protection from coastal flooding, these levees are not certified by FEMA. The levees are not certified because their crest elevation is below the 1% water level freeboard requirements and they likely do not meet geotechnical specifications. Since the levees lack certification, FEMA considers the levees to fail at stopping or reducing the inland propagation of the 1% still water level.

Public Health (PH): The health-related impacts of climate change, with a special focus on the City's populations who are most vulnerable those impacts, including those with special needs, living in poverty, or most exposed to the physical impacts of climate change. In terms of public health, climate change vulnerability is a function of an individual or a community's ability to respond and adapt to climate stressors, which in turn is dependent on socioeconomic characteristics and underlying health and physical abilities.

Buildings and Property (BP): This asset category includes homes, businesses, commercial and industrial buildings, government buildings, schools, parks and recreation areas, and other property assets. Palo Alto encompasses a mix of high value private properties that are important to the well-being of the community, including several commercial zones, mixed use residential/commercial areas, neighbourhoods of stately and historical homes, high-tech and light industrial employment districts, and several concentrated employment centers (Stanford Research Park, Stanford Medical Center, East Bayshore, and San Antonio Road/Bayshore Corridor). In 2013, the median home sales price in Palo Alto was $1,720,000, more than 2.5 times that of the County median price of $645,000.

Solid Waste/Hazardous Materials Management(SM): Solid waste facilities including landfills, materials recovery facilities, transfer stations, composting facilities; also includes hazardous waste management facilities, contaminated land sites, and the inactive City-owned Class III landfill and landfill gas collection system that could be vulnerable to flooding and erosion from sea level rise.

Natural Areas/Ecosystems (NE): This includes natural environments and habitats considered valuable or essential to the health and well-being of the community, including the rich variety of plants, animals, and other organisms that reside in City of Palo. The Natural Environment element of the City's Comprehensive Plan ("Embracing the New Century") identifies 29 neighborhood and district parks in the City totaling approximately 190 acres and larger open space preserves primarily located in the southern foothills but also along the Bay on the northeastern edge of the City. In addition to these facilities, there are a variety of other facilities in Palo Alto that serve to reduce the demand for City-owned and operated natural and recreational areas. These include lands owned by Palo Alto Unified School District used for recreation, Stanford University open space and recreation lands, privately owned recreational facilities, land managed by conservation groups, and State and regional parks in the vicinity of Palo Alto. Approximately 59 percent of land within the Palo Alto City limit is park land, open space, or public conservation land, compared to 40.5 percent in 1996. Palo Alto's open space preserves, located primarily in the southern foothills but also extending along the Bay on the northeastern edge of the City, provide opportunities for hiking, biking, fishing, picnicking, camping, nature study, and non-motorized boating. They also have significant ecological and aesthetic value, providing important habitat for wildlife and a scenic backdrop to the urban area.

Other Important Community Assets

The Cultural Resources element of the Draft 2014 General Plan outlines the City's archeologically sensitive areas, which range from prehistoric sites and artifacts from early communities in the area and historic structures from the more recent past. The City also contains several paleontological resources including site where fossils of extinct marine mammals and other prehistoric plant and animal life have been found. The City maintains an inventory of historic sites, which contains approximately 450 structures of historic merit ranging from the thousand-year old "El Palo Alto" redwood tree, where early Spanish explorers are believed to have camped, to the HP garage, where Bill Hewlett and Dave Packard started the Hewlett Packard Company in 1939.

Climate Change Exposures

Using Cal-Adapt and other available tools, ESA summarized the type, magnitude, and onset of various local exposures of climate change that Palo Alto can expect to experience by the years 2050 and 2100, as predicted for the high emissions (A2) and low emissions (B1) scenarios by global climate models. The exposure analysis considers the effects of climate change on local temperature, local precipitation, drought, wildfire, and sea level rise, as well as the secondary exposure pathways facing the City of Palo Alto.

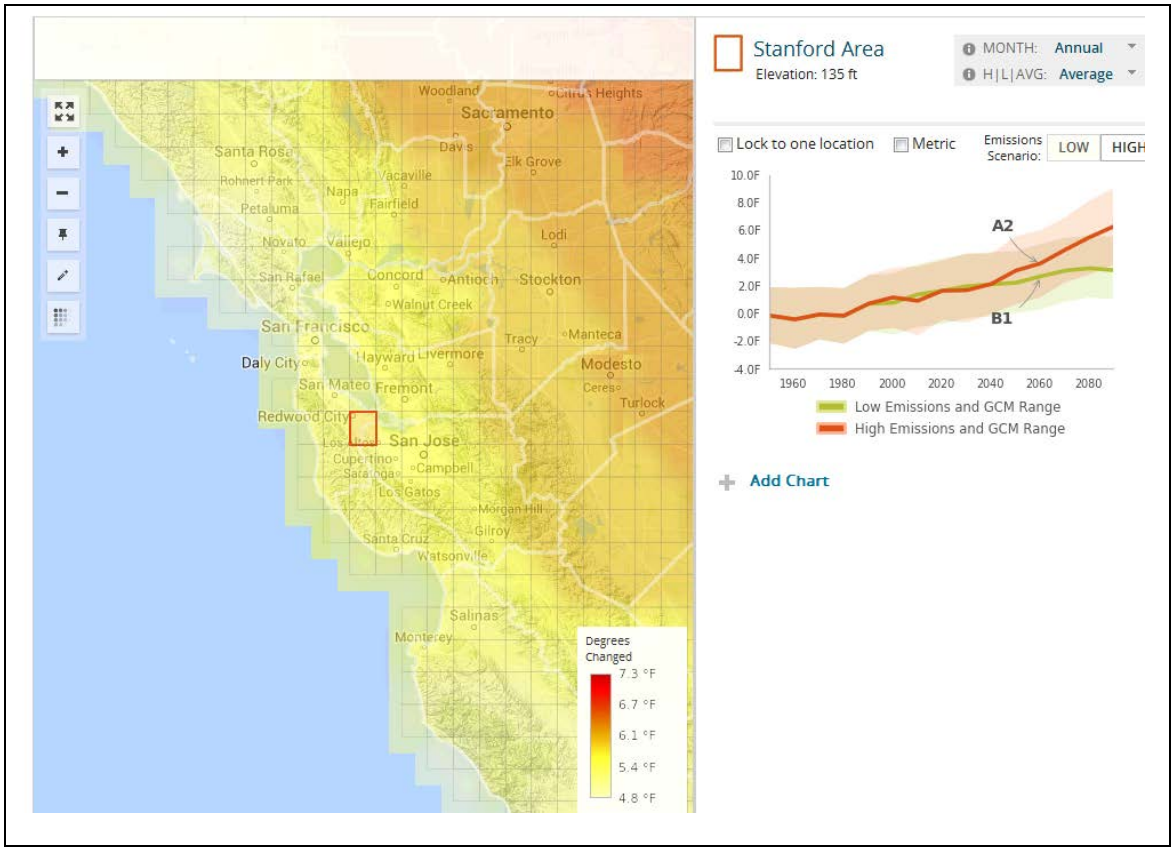
Temperature

California in general expects overall hotter conditions for both mean and extreme temperatures. An increase in heat waves and wildfires are expected to be among the earliest climate impacts experienced across the state. [32]

Figure 6.1, generated from Cal-Adapt, indicates that between A2 and B1 scenarios, the Palo Alto can expect to experience a rise in average annual temperature of about 2 to 6 degrees Fahrenheit above the historical average by the end of the century. Figure 6.2 shows the expected increase in extreme heat days, defined in the Cal-Adapt tool as a day in April through October where the maximum temperature exceeds the 98th historical percentile of maximum temperatures based on daily temperature data between 1961-1990. By the year 2100, Palo Alto is expected to experience approximately 30 extreme heat days per year under the low emissions (B1) scenario, compared to a historical average of about 4; under the high emissions scenario (A2), the expected number of extreme heat days doubles to approximately 60, as shown in Figure 6.3.

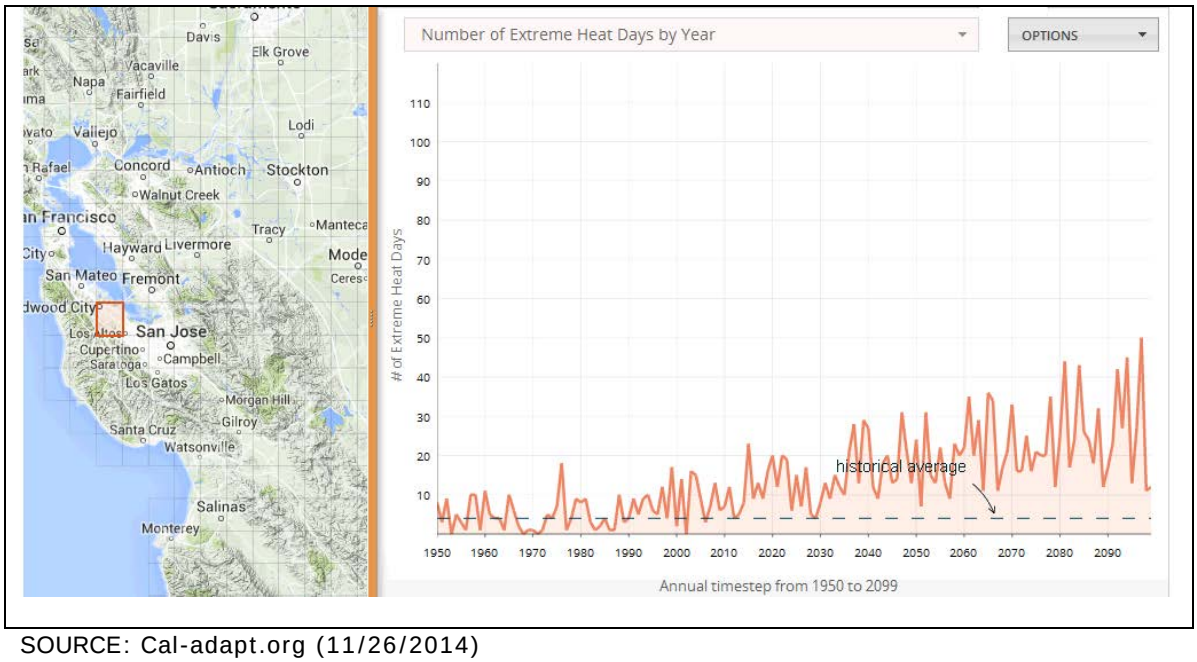
Figure 6.1: Projected Change in Annual Average Temperature for A2 and B1 Scenarios

[32] California Natural Resources Agency, 2014, Safeguarding California: Reducing Climate Risk; An update to the 2009 California Climate Adaptation Strategy, http://resources.ca.gov/climate/safeguarding/



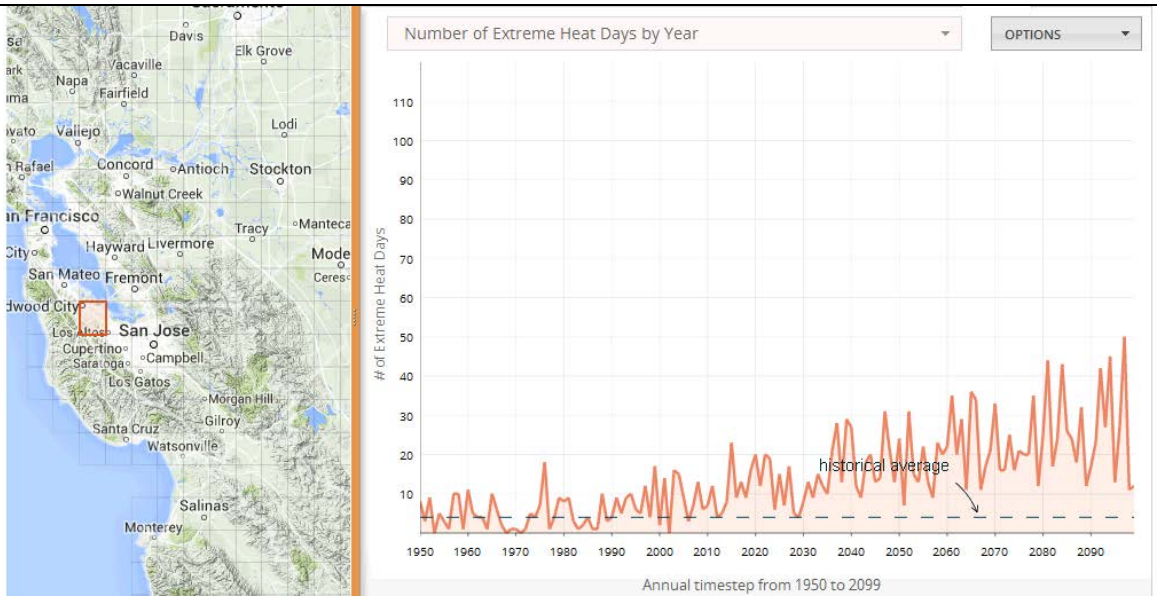
SOURCE: Cal-adapt.org (11/26/2014)

Figure 6.2: Number of Extreme Heat Days per Year low emissions (B1) scenario



SOURCE: Cal-adapt.org (11/26/2014)

Figure 6.3: Number of Extreme Heat Days per Year low emissions (B1) scenario



SOURCE: Cal-adapt.org (11/26/2014)

Because of these temperature increases, heat-related illness and mortality are expected to increase. Though extreme heat events in coastal areas like the City are not expected to be as severe or as long-lasting as further inland, the resident population is not as well prepared or equipped to deal with higher temperatures. Air conditioning is far less common, for example. Outdoor workers, elderly populations, and infants are particularly vulnerable to extreme temperatures.

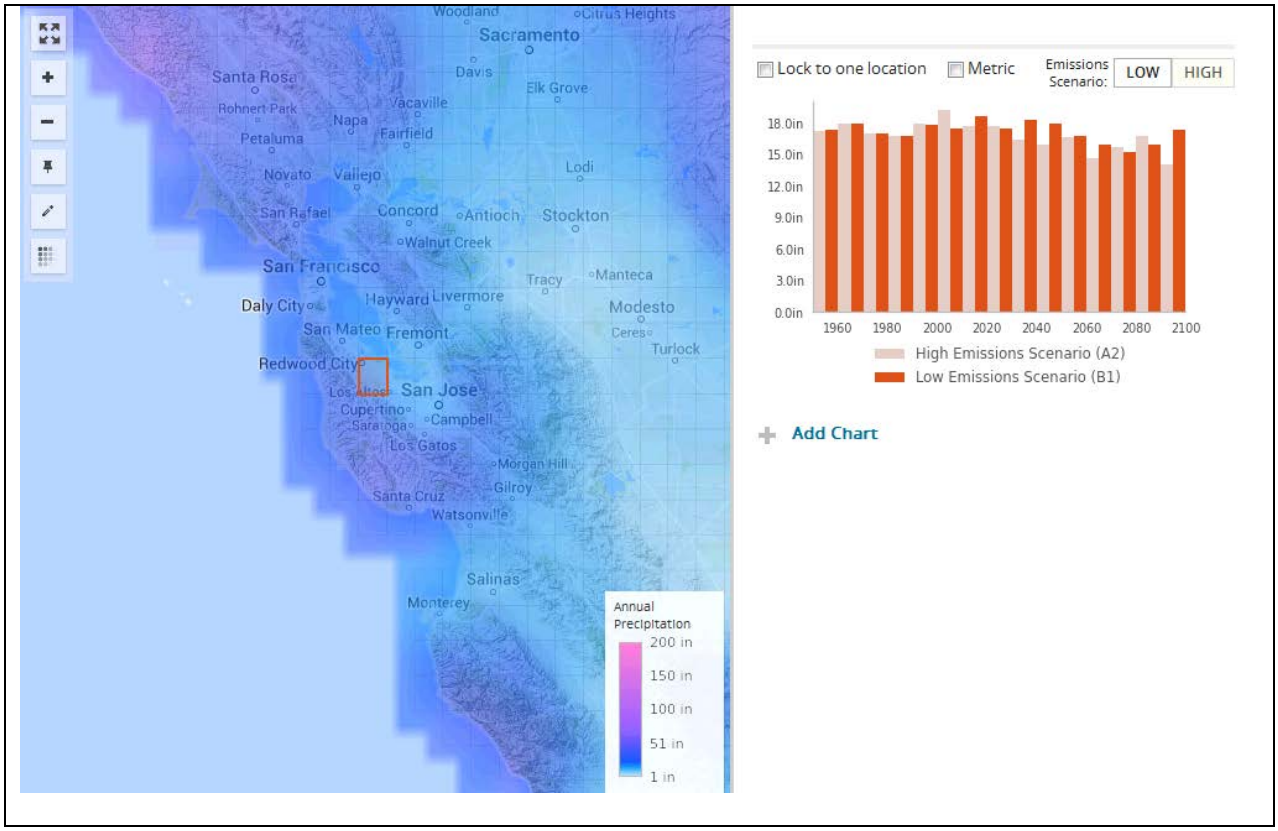
Higher temperatures and drier summer conditions produce higher levels of ozone and increase the potential for wildfires, both of which could lead to declines in air quality and negative impacts to respiratory and cardiovascular health.

Precipitation

Local precipitation exposures encompass changes in annual averages as well as peak events during extreme storms. Since the City already has an arid climate, it is sensitive to a decrease in annual local precipitation, which can cause local drought, impacting local flora and contributing to wildfire risk (for regional drought and impacts to water supply, see Section 0 below; for wildfire risk see Section 0 below). An increase in local precipitation during extreme storms can increase the peak storm runoff, thereby increasing the risk of flooding due to the overtopping of stormwater channels, pipes, pumps, and creeks.

Figure 6.4 shows that the average annual precipitation in the City of Palo Alto, when averaged across global climate models and decades, is expected to decrease slightly by 2100 under both emissions scenarios. Individual GCMs predict larger changes, with some GCMs predicting decreased annual precipitation and other GCMs predicting increased annual precipitation. These opposing directions of change result in the relatively small net change when averaging all GCMs. This range in GCM predictions is representative of the current uncertainty as to the potential effects of climate change on precipitation.

Figure 6.4: Decadal Average Precipitation to 2100 for A2 and B1 scenarios



SOURCE: Cal-adapt.org (11/26/2014)

Extreme storms include periods of intense rainfall that can overwhelm the City's storm drain and creek flood management systems, causing flooding. The current stormwater drainage system is designed for extreme precipitation based on historic climate data. Based on the GCM that projects generally wetter conditions for the Bay area, there some chance that the precipitation from individual storms could increase by approximately 10%, as shown in Table 6-1. Selecting the wetter GCM and the higher end of the precipitation distribution is more conservative and thus more risk averse.

Table 6-1: Projected Changes in Peak Precipitation

Extreme Precipitation	Time horizon	Emissions Scenario	Average for Watersheds Overlapping City Boundary
% Change in 98th percentile 1-day rainfall relative to 1970-2000 average (Parallel Climate Model - Wet GCM)	2050	B1	6%
		A2	4%
	2100	B1	12%
		A2	5%

Along the Bayshore, higher average sea levels will elevate Bay water levels, which can impede the drainage of precipitation via the creeks. This exposure will be felt most prominently at the Palo Alto Flood Basin, which stores creek discharge within the coastal flood plan and can only drain to the Bay

through tide gates when Bay water levels are sufficiently low. Since this exposure is caused by sea level rise, it is addressed in Section 0 below.

Drought

As outlined in the City's 2010 UWMP and the Bay Area IRWMP, regional changes in precipitation and temperature patterns present a long-term risk to the region's water supply. Expected impacts include reductions in the average annual Sierra snowpack and a shift in snowmelt runoff to earlier in the year; changes in the timing, intensity and variability of precipitation, and an increased amount of precipitation falling as rain instead of as snow; long-term changes in watershed vegetation and increased incidence of wildfires that could affect water quality. Higher temperatures would also increase evaporation which in turn would increase irrigation demand.

The primary drought-related risk of concern to Palo Alto is the long-term viability of its water supply, as described in earlier sections. A related risk of concern is the secondary impact of drought in reducing the City's available hydroelectric supply. The LHMP considers exposure to drought and concludes that the City of Palo Alto does not have any unique concerns regarding the hazard of drought as presented in Section 4. However, that analysis does not consider the wider implications of regional drought on the City's water supply. More frequent or more intense droughts could also stress local flora and fauna.

Wildfire

Wildfire frequency and intensity are expected to increase in California due to warmer temperatures, longer dry seasons and decreased plant moisture. This is especially true in mountainous areas along the northern coast and the Sierra Nevada. More fires will increase public safety risks, damage property, stress local fire suppression capabilities and drive up emergency response costs to the local government. Wildfires also impact watersheds, water quality, and wildlife habitat.

The City of Palo Alto has a Foothills Fire Management Plan, which has been adopted as a Community Wildland Protection Plan: http://www.cityofpaloalto.org/civicax/filebank/documents/27163

Figure 6.5: Change in Fire Exposure Risk, Showing Community Asset Locations

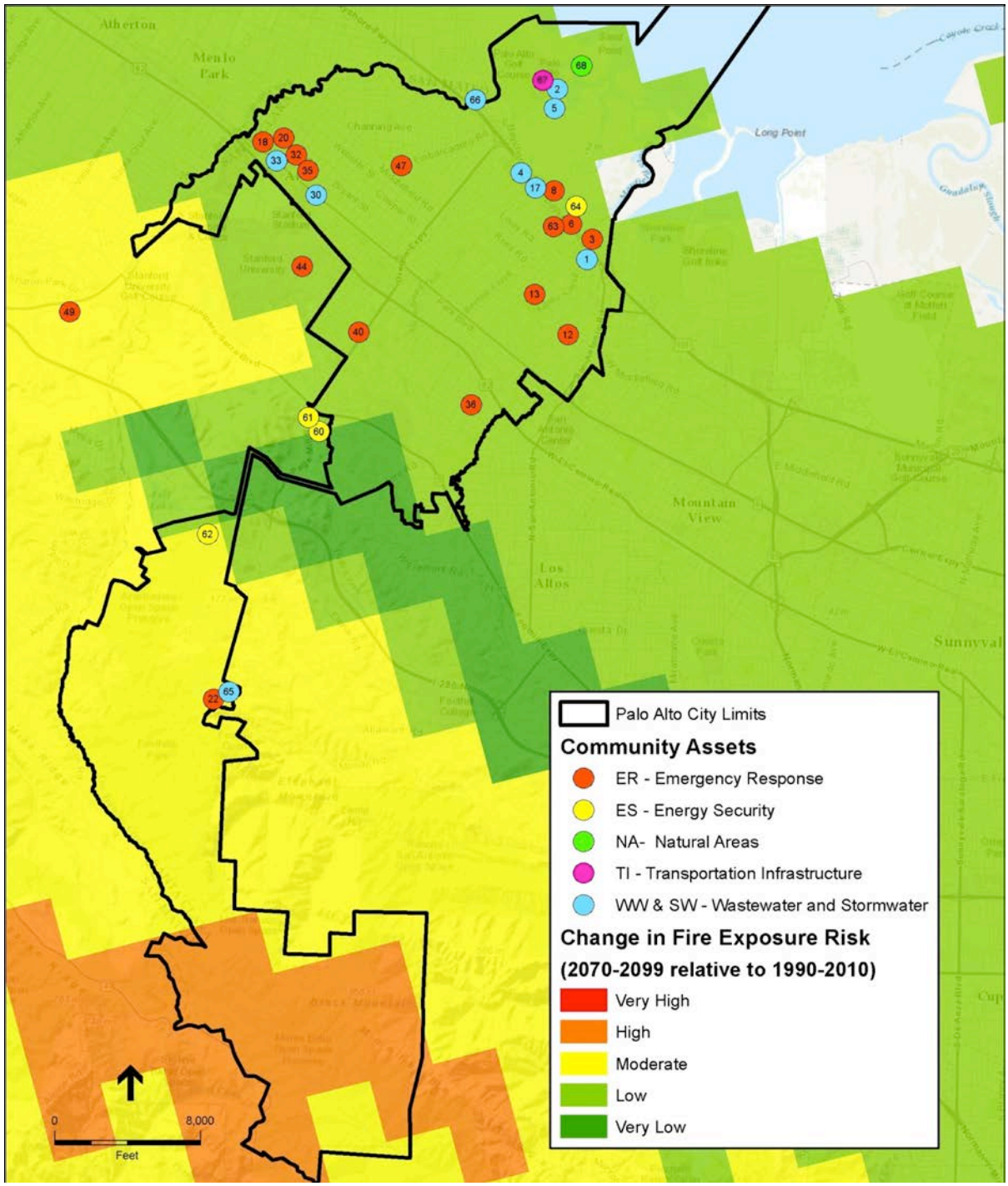


Figure 6.5 shows the expected change in fire exposure risk in the City from current baseline (2000 to 2010) to the end of the century (2070 to 2100), based on recent modeling done by the California

Department of Water Resources (DWR).[33] DWR assessed data on fire probability generated by Krawchuk and Moritz (2012)[34] to map the probability of 1 or more fires occurring within 30-year time periods from 1971-2000, 2010-2039, 2040-2069, and 2070-2099. The map in Figure 6.5 shows that the risk of fire will greatly increase by 2070 in the hills and open space preserves of Palo Alto's southwestern corner, and moderately in the areas west of Interstate 280. (Note: for security purposes, critical infrastructure assets are not shown on the map; these include electrical substations, gas receiving stations, water reservoirs, well sites, water booster stations and water receiving stations.)

Sea Level Rise

As discussed in Section 0, the 2012 NRC report projects 11 inches of sea level rise in the Bay by 2050 (with a range of 5 to 24 inches) and 36 inches by 2100 (with a range of 17 to 66 inches).

Figure 6.6 shows the City's current coastal flood hazard and future exposure from sea level rise inundation (Note: for security purposes, critical infrastructure assets are not shown on the map; these include electrical substations, gas receiving stations, water reservoirs, well sites, water booster stations and water receiving stations). This mapping is based on the proximity to the Bay, ground surface elevation, extreme Bay water levels, and the lack of certified levees. As delineated by the orange line and blue crosshatch in Figure 6.6, much of the City northeast of Middlefield Road is in the existing FEMA 100-year (or 1% annual chance) coastal flood zone. This is because the land surface elevations in this area are below the estimated 100-year Bay water level and the levees have not been certified by FEMA. The FEMA coastal floodplain surrounds multiple City critical assets.

The City's additional exposure to coastal flooding due to sea level rise was estimated with projections by the USGS (Knowles, 2010[35]). For the first mapped increase of sea level, 19 inches (50 cm), there is not much change in inundation area because of the relatively steep land surface slope between the existing 100-year water level and that predicted level for 19 inches of sea level rise. As a result, there are not many additional structures in the FEMA floodplain. However, inundation in this area would be more frequent and deeper, thereby increasing expected damages. Correspondingly, to reduce these damages, the design elevation would increase for the levee crest or for the first habitable floor of structures not sheltered by a certified levee. With the second mapped increase of sea level, 39 inches (100 cm), there is significant increase in inundated area, as indicated by the darker blue shading. This greater change in inundated area for the same increment in sea level rise (i.e. the additional 20 inches) occurs because the increment occurs over a flatter land surface slope. Like the first increment of sea level rise, the increase to 39 inches would also create increases of inundation frequency, depth, and damages.

FEMA recently developed updated total water levels and wave run-up distributions for its Regional Coastal Hazard Modeling Study for South San Francisco Bay (DHI, 2013[36]). These distributions provide

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[33] DWR, 2014: *Fire Exposure Assessment Methodology.* Climate Change Team: Andrew Schwarz, Aaron Cuthbertson, Erin Chappell, Michelle Selmon.

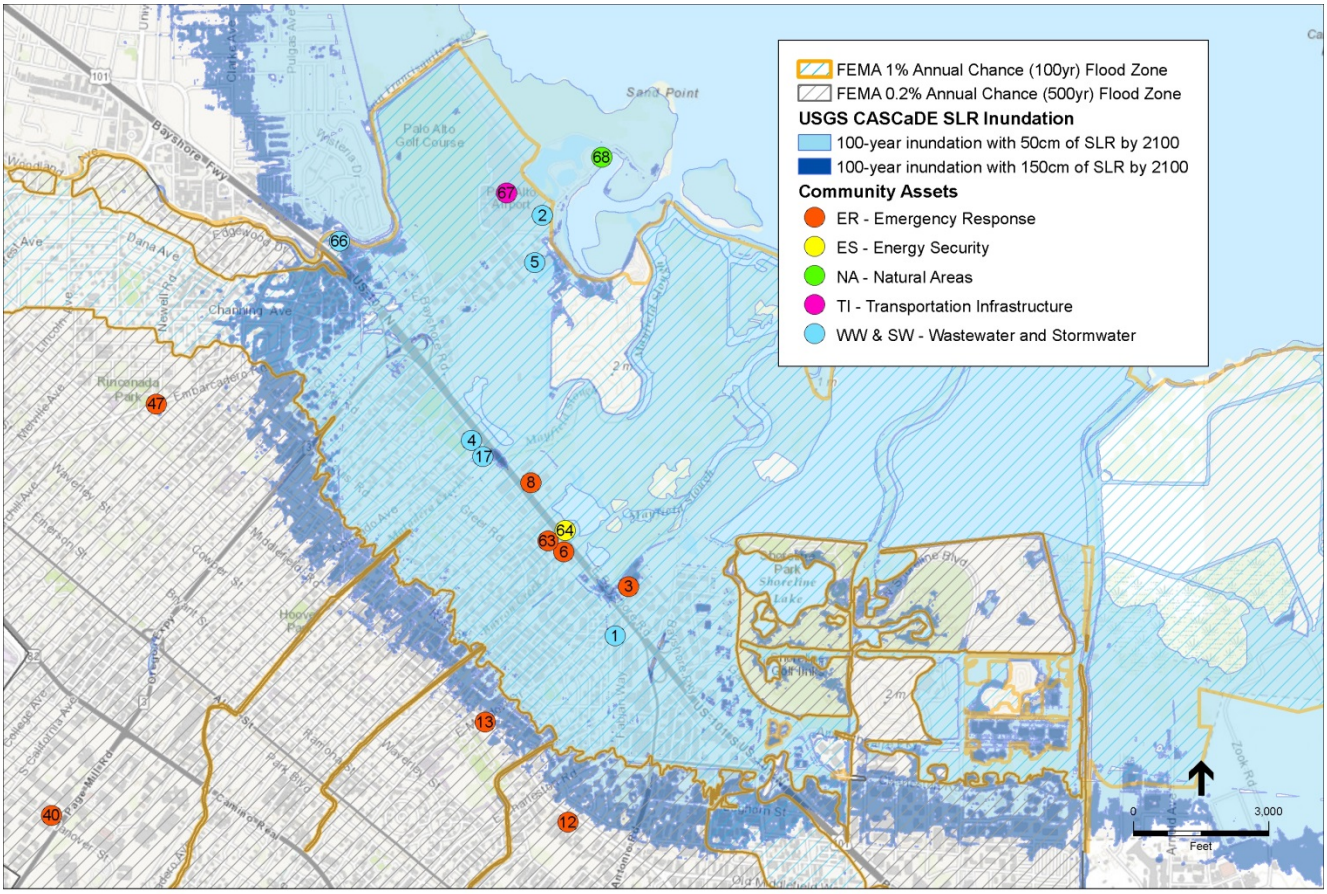
[34] Krawchuk, M. A., and M. A. Moritz (Simon Fraser University; University of California, Berkeley). 2012. *Fire and Climate Change in California*. California Energy Commission. Publication number: CEC-500-2012-026.

[35] Knowles, N. 2010. Potential Inundation Due to Rising Sea Levels in the San Francisco Bay Region. San Francisco Estuary and Watershed Science, 8:1.

[36] DHI. 2013. Regional Coastal Hazard Modeling Study for South San Francisco Bay Final Draft Report. Prepared for FEMA Region IX.

recurrence interval data for water levels and waves for present day conditions. This study provides recent, local estimates of present Bay water levels in the absolute North American Vertical Datum (NAVD). By adding sea level rise projections (NRC, 2012), future water levels can be projected, as summarized in Table 6-2. Note that these values do not include the effect of waves, which, depending on local shoreline characteristics, may increase flood hazard. Comparing the values between columns in Table 6-2 characterizes the effect of sea level rise on water level frequency. For example, the present 10-year water level of 9.7 ft NAVD will occur nearly annually as a King Tide by mid-century. Similarly, the present 100-year water level of 11.0 ft NAVD will be exceeded annually by a King Tide by end-of-century.

Figure 6.6: Palo Alto Community Assets at Risk from Sea Level Rise and Associated Flooding



SOURCE: USGS (SLR inundation), FEMA (flood zones), City of Palo Alto (City Limits, asset locations), ESRI (basemap background)

City of Palo Alto SCAP . D140455.00

Palo Alto Flood Risk and Community Assets Map

Table 6-2: Palo Alto Shoreline Bay Water Levels for Today (DHI, 2013) and for Projected Sea Level Rise (NRC, 2012)

Water Level	Present ft NAVD	Mid-century 11 inches	End-of-century 36 inches

		ft NAVD	ft NAVD
MSL	3.5	4.4	6.4
MHHW	7.4	8.3	10.4
King Tide (Annual Astronomic Peak)	8.6	9.5	11.6
10-year	9.7	10.6	12.7
100-year	11.0	11.9	14.0

Even if peak precipitation and associated runoff are relatively unaffected by climate change as currently projected (see Section 0), sea level rise could impact the stormwater management system since the system ultimately drains into the Bay. The discharge rate to the Bay decreases as Bay water levels increase. Reduced discharge rates will cause higher water levels upstream in the stormwater system, a process sometimes referred to as 'backwatering'. Stormwater pump stations that already rely on mechanical action to discharge water are typically not that sensitive to the water levels in the Bay (ESA PWA, 2012[37]). However, discharges that rely solely on gravity can be sensitive to Bay water levels. The PAFB, which receives discharge from three of the City's creeks, drains by gravity to the Bay. Because of tide gates at the Flood Basin's outlet, discharge to the Bay only occurs when Bay water levels are lower than water levels in the Flood Basin.

Other coastal flood hazard assessments are underway or planned for the City's shoreline. These assessments include:

- FEMA is in the process of revising its 100-year coastal floodplain maps for Santa Clara County, including the City. This revised mapping only considers current conditions and does not include sea level rise. It differs from the existing maps (i.e., what is shown in Figure 6.6) in that it uses the most recent hydrodynamic modeling (DHI, 2013) and considering the role of waves as per the most recent FEMA mapping guidelines (FEMA, 2005[38]).
- The collaborative project Our Coast, Our Future (OCOF) recently released sea level rise inundation maps for the Bay area (Ballard et al., 2014[39]). For the scenario with no sea level rise and the annual storm, OCOF results predict inundation of more than 600 acres of developed City property. Flooding this extensive has not been observed in Palo Alto, indicating that the OCOF modeling has issues resolving storm-induced water levels and/or levee topography in this area. OCOF's predictions of scenarios with higher water levels due to sea level rise and storm intensity are generally consistent with the USGS projections shown in Figure 6.6.

[37] ESA PWA. 2012. Shoreline Regional Park Community Sea Level Rise Study Feasibility Report and Capital Improvement Program. Prepared for the City of Mountain View.

[38] FEMA. 2005. Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States. A Joint Project by FEMA Region IX, FEMA Region X, FEMA Headquarters.

[39] Ballard, G., Barnard, P.L., Erikson, L., Fitzgibbon, M., Higgason, K., Psaros, M., Veloz, S., Wood, J. 2014. *Our Coast Our Future* (OCOF). [web application]. Petaluma, California. www.pointblue.org/ocof. (Accessed: January 5, 2015).

- Santa Clara Valley Water District, in collaboration with the U.S. Army Corps of Engineers, is in the process of analyzing the City's flood hazard for existing conditions with sea level rise for the Shoreline Study. The results of this analysis are expected in 2016.

In addition to these primary exposures, sea level rise may also entail several secondary exposures. For instance, the higher Bay water levels may expose portions of the shoreline to additional erosion potential. These newly exposed portions may not have suitable bank protection to resist erosion. In addition, increased Bay water levels will alter the groundwater gradients along the shoreline, possibly causing landward salinity intrusion. This change will be most directly impact to the surface aquifer, which is not currently used for water supply. However, this surface aquifer does interact with some City assets, such as infiltration into the City's stormwater collection system and the landfill.

Vulnerability

Vulnerability is the degree to which facilities, systems, and services are susceptible to the climate change exposure (changes in sea level rise, temperature, and precipitation). This section is organized around eleven functional categories of community assets, systems and services that are vulnerable to climate change. In evaluating vulnerability, both the exposure to climate change impacts and the consequences are considered. As defined by the California Climate Adaptation Planning Guide (Steps 1 through 5 in Figure 2.1), vulnerability is determined by the following:

- **Exposure:** What climate change effects will a community experience?
- **Sensitivity:** What aspects of a community (people, structures, and functions) will be affected?
- **Potential Impacts**: How will climate change affect the points of sensitivity?
- **Adaptive Capacity:** What is currently being done to address the impacts?
- **Risk and Onset:** How likely are the impacts and how quickly will they occur?

The following sections provide preliminary vulnerability assessments of City of Palo Alto functional asset categories, identifying specific assets at risk as well as general services or capabilities at risk, based on exposures and potential impacts from climate change. It is important to point out the inter-related nature of these functional categories with respect to climate change vulnerability. Due to cascading impacts, it is not always obvious where true vulnerabilities lie. For example, the loss of power during a storm could impact the ability of the local waste water treatment plant to adequately treat inflowing sewage, while stormwater overflow that is directed to the plant could exceed the plant's treatment capacity. The combination of these factors leads to a much bigger emergency than does each factor in isolation. Thus, it is important for the City's planners and managers to consider inter-related systems when assessing vulnerability.

Emergency Response and Communications (ER)

This functional category includes facilities that are critical in times of emergencies and natural disasters, including hospitals and other medical facilities, telecommunications infrastructure, cooling centers, police and fire stations, emergency operations centers and evacuation shelters. In Palo Alto, higher average sea levels in the future will lead to storms impacting the Bay shore more frequently with higher storm surges, more extensive inland flooding, and increased erosion. If more frequent or severe natural disasters occur, existing emergency response and communications services may not be adequate to deal with the consequences. Extreme storms and extreme heat combined with drought may also strain emergency response systems.

Table 7.1 summarizes the primary vulnerabilities of Emergency Response and Communications facilities and systems within the City. Refer to Figures 6.5 and 6.6 for the locations of assets at risk from flooding and wildfire. The LHMP identifies Fire Station #8 as being located in a high risk fire hazard zone. The City staffs a brushfire rig at Fire Station #8 on red flag days, and is exploring the feasibility of installing a fire monitoring system in the foot hills, along with increased outreach and education to the area's residents.

The City of Palo Alto operates its own fiber optic utility, with CPAU providing day-to-day responsibility for operating and maintaining the dark fiber optic backbone system ("fiber system"). The 41-mile fiber system supports multiple network developers and service providers, and is routed to pass and provide access to key City facilities and offices such as IT Infrastructure Services, electric utility substations, traffic signals, libraries and the Wastewater Treatment Plant. The majority of the City's business parks (e.g. Stanford Research Park) and commercial properties are also passed by the fiber backbone.

Silicon Valley 2.0 assessed fiber optic line location data provided by Metromedia, the major provider of internet infrastructure in the Bay Area, and found no fiber optic lines vulnerable to sea level rise in Santa Clara County, but a small portion of fiber optic line near San Francisquito Creek in Palo Alto was found to be within the 100 year FEMA floodplain and vulnerable to fluvial flooding. Several communication towers in the southwestern portion of Palo Alto were also found to vulnerable to wildfire hazard. The Silicon Valley 2.0 report findings did not consider the dark fiber network operated by City of Palo Alto.

TABLE 7-1. Climate Change Vulnerability of Emergency Response Capabilities		
Function	Facilities and services that are essential to the safety and survival of the City population in times of emergencies and natural disasters, includes emergency response capabilities, communications, and critical City operations	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Higher temperatures combined with dry conditions increase wildfire risk.	• Fire suppression capability
Precipitation	• Higher risk of fluvial flooding of critical facilities such as MSC and key access roads • Potential to interrupt power supply.	• Municipal Service Center (map #8), • Utilities Control Center (map #6) • Low lying access roads (e.g., Oregon Expressway 101 Underpass) • City of Palo Alto dark fiber network • Metromedia fiber optic line near San Francisquito Creek
Drought	• Dry conditions increase the risk of wildfire. • Stress on water supply	• Fire suppression capability
Wildfire	• Excessively dry periods increase the risk of wildfires at the urban-wild interface along the eastern portion of the City.	• Fire suppression capability, including Fire Station #8 (#22 on map). “Red flag” fire days can stretch the capacity of the emergency response capabilities of the Palo Alto Fire Department. • Communication towers in the foothills

Sea Level Rise	• Increased frequency and depth of coastal flooding • Increased potential for fluvial flooding due to reduced drainage to the Bay • Flooding of low-lying roads, highways, and airport could hinder or prevent access by emergency vehicles. • Flooding of operation and control centers could disrupt critical communications, emergency response and recovery, and utility operations.	• Municipal Service Center (map #8), including utility vehicles for the Public Works and Utilities Departments; access roads to MSC also at risk • Utility Control Center (map #6) • Palo Alto Airport: used as helicopter base by Office of Emergency Services • City of Palo Alto dark fiber network

The web site City-Data.com identifies the following hospitals and medical centers in Palo Alto.[40] None of these facilities are considered vulnerable to flooding, sea level rise, or wildfire risk through the year 2100, based on their locations relative to these impacts as shown on Figures 6.5 and 6.6:

- Lucile Packard Stanford Pediatric Dialysis Facility (725 Welch Road Pediatric Dialysis Rm 1229);
- Stanford Home Care (1520 Page Mill Road);
- Lucile Salter Packard Children's Hospital At Stanford (725 Welch Road);
- Palo Alto VA Medical Center (Hospital, Acute Care - 3801 Miranda Avenue);
- Surgecenter Of Palo Alto (Hospital, 795 El Camino Real);
- Bay Healthcare - Palo Alto (Nursing Home, 4277 Miranda Ave);
- Casa Olga Intermediate Health Care Facility (Nursing Home, 180 Hamilton Avenue);
- Lytton Gardens Health Care Center (Nursing Home, 437 Webster Street);
- Palo Alto Nursing Center (Nursing Home, 911 Bryant Street);
- VI At Palo Alto (Nursing Home, 600 Sand Hill Road).

Energy Security and Infrastructure (ES)

[40] City-Data.com: http://www.city-data.com/city/Palo-Alto-California.html, accessed December 23, 2014.

This functional asset category includes critical local facilities for the City's energy security including power stations, transmission lines, gas pipelines, and the City's reliance on regional infrastructure and hydropower generation from Sierra Nevada watersheds. In addition to the anticipated decline in overall precipitation, the quality and timing of winter precipitation will also impact Palo Alto's power supply.

Palo Alto's energy utility operations and dispatch of service vehicles are centralized at the Palo Alto Municipal Services Center, located at 3201 E. Bayshore Road.

Electricity and Power

Numerous studies have highlighted the impact of climate change on California's energy infrastructure, which in turn impacts power availability to the City. The California Energy Commission's report (CEC - 500 - 2012 - 057, Estimating Risk To California Energy Infrastructure From Projected Climate Change, 2012) highlights a constellation of negative climate change impacts on the grid system including higher temperature impacts on power plant capacity, electricity generation, transmission lines, substation capacity, and peak electricity demand; increased wildfire frequency or severity and the resulting impacts near transmission lines; and sea level encroachment upon power plants, substations, and natural gas facilities. The study suggests that up to 25 coastal power plants and 86 substations in California are at risk of flooding (or partial flooding) due to sea level rise.

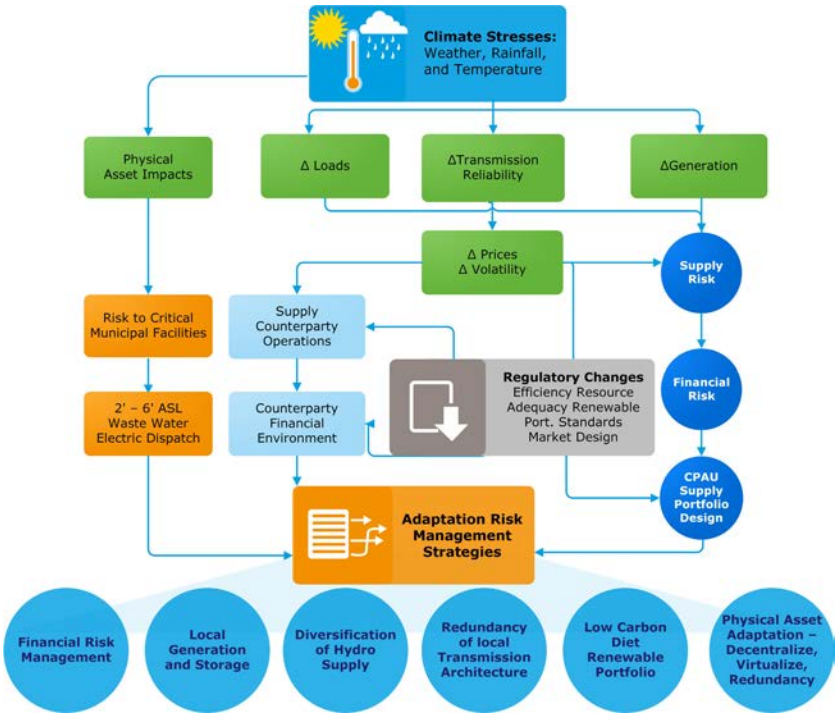
The CEC study looks at impact on three timescales:

- Near-term (+2°C warming) impacts of between 1.4 to 13.9% decrease in hydropower, with an average decline of 8.3%
- Mid-term (+4°C warming) impacts of between 3.6 to 31.8% decrease in hydro power with an average decline of 15.4%
- Long-term (+6°C warming) impacts of between 5.8 to 35.2% decrease in hydro power with an average decline of 20.3%.

Overall, the CEC study suggests that by end of century hydropower generation will drop from a baseline of 17,413 GWh to 13,875 GWh in the study area (Sierra Nevada), which supplies 75% of California's hydro power. The study also shows that a majority of the reductions in hydropower generation occur in the highly productive watersheds in the northern Sierra Nevada serving Palo Alto.

The City has recognized as well that changes in precipitation patterns caused by climate change will directly affect the availability of hydropower for the City. The city receives a percentage of power generated by the Western Area Power Administration's Central Valley Project and the Calaveras Hydroelectric Project. In addition to the impacts of reduce precipitation caused by a decline in precipitation, the quality and timing of precipitation will also impact Palo Alto's power supply. In particular, reduced hydropower availability will result from overall higher altitudes for the snow line therefore reducing late season inflows into reservoirs, more mid-winter rainfall events which will reduce snowpack, and an overall reduction in water stored as snow above reservoirs. A review of these risks by the City of Palo Alto suggest a 10 to 20% decline in water storage and generation from the City's hydro resources and a 20 to 40% decline in generation during peak June to September

periods in California by 2050.[41] The figure below illustrates some of the multiple stresses and financial risks to the City as a result of climate related changes in the hydropower supply.



Natural Gas Infrastructure

The City maintains four delivery "gate stations" where the city receives gas from the PG&E transmission system. The city's natural gas distribution network consists of about 205 miles of mains (2" to 12" in diameter) and 18,000 service lines (0.5" to 6") which connect customers with the service mains.

A potential climate risk to the natural gas pipeline is inundation of pumping stations due to temporary flooding or sea level rise. The City's list of critical assets includes four natural gas stations. These are located at 3241 E Bayshore Rd, 1735 Embarcadero, Alma & Colorado, and 1961 Old Page Mill Rd. The first two of these stations lie within the potential inundation zone outlined by the ESA and BCDC risk mapping (see Figure 6.6).

[41] Van Orsdol, Karl G., and Karl Knapp: *A Practical Look at Managing Climate Risk – A Municipal Utility Perspective*; City of Palo Alto; available at http://www.cityofpaloalto.org/civicax/filebank/documents/7481

TABLE 7-2. Climate Change Vulnerability of Energy Security and Infrastructure

Function	Facilities and systems essential to the supply and transmission of electricity and natural gas to City residents, businesses and government services.	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Transformers exploding • Overhead lines sagging • More frequent and severe heat waves lead to energy usage spikes • Thermal inefficiency in generating plants could reduce energy supplies to grid system • Degraded efficiency in transmission lines could disrupt supplies.	• Transmission Assets (PG&E owned) • Supply Assets due to: • Reduced transmission grid reliability • Reduced transmission capability to supply reserve power • Increased congestion within load pocket
Precipitation	• Flooding from San Francisquito Creek • Loss of access to facilities	• Utility Control Center (map #6) • Municipal Service Center, including utility vehicles (map #8) • Adobe Creek Substation • Utility Engineering Center (map #3) • Colorado substation • Ames substation
Drought	• Reduced snowpack for hydropower generation • Insufficient hydropower supplies to meet load requirements, resulting in the need to purchase additional renewable energy to replace the reduced hydrogeneration while maintaining a carbon neutral electric supply portfolio	• Long-term hydroelectric power supply risk • Electric reserve fund could be impacted by short term price volatility. • Short-term supply: Possible brownouts and black outs if supply disruption impacts larger grid system • Additional REC purchases required if increased wholesale power

		purchases required.
Wildfire	• Grid disruption could result when wildfires disrupt or impede grid transmission interrupting the delivery of energy supplies.	• Distribution/power lines in higher risk zones near urban forests and open spaces • Gas station #3 • SLAC interconnect (planned)
Sea Level Rise	• Increased frequency and depth of coastal flooding of energy facilities • Increased potential for fluvial flooding due to reduced drainage to the Bay • Increased inundation and rising groundwater may limit access to facilities and infrastructure for maintenance and operations; Inability to access transmission towers.	• Utility Control Center (map #6) • Municipal Service Center, including utility vehicles (map #8); access roads to MSC also at risk • Utility Engineering Center (map #3) • Adobe Creek Substation • Colorado substation • Other at-ground substations in the eastern areas of the city and in underground locations.

Water and Wastewater

Water and Wastewater includes three functional asset categories of Water Supply, Wastewater Management, and Stormwater Management.

Water Supply (WS)

This functional asset category includes natural and manmade water systems for supplying clean, safe and reliable water supply for the City of Palo Alto, including potable water reservoirs, groundwater wells, piping systems, pumping stations, turnouts, and water treatment infrastructure.

The City's current water supply is highly vulnerable to drought, but the risk of failure is uncertain. The City is dependent on City and County of San Francisco's Regional Water System (RWS), operated by SFPUC, for the bulk of its long-term water supply. During periods of extended drought, the ability of SFPUC to supply its wholesale customers (including City of Palo Alto) is at risk, though SFPUC has reported as recently as 2009 that it does not consider its regional supply to be at significant risk from climate change through the year 2030. However, California's current drought, now in its fourth year, is putting added emphasis on long-term water security and forcing public agencies to redouble conservation efforts and expand contingency planning. Both SFPUC and the City of Palo Alto are increasing efforts to improve conservation, upgrade storage and delivery systems, and diversify local water supplies.

With the Emergency Water Supply and Storage Project now completed, the City owns eight wells that access the City's deep aquifer that could provide potable water in a drought emergency. Three of

those wells are vulnerable to flooding from sea level rise and stormwater flooding: the Library Well at 1213 Newell Road; the Eleanor Pardee Well at 851 Center Drive; and Rinconada Well at 1440 Hopkins Avenue.

Palo Alto encompasses significant land areas in the foothills and elsewhere that are highly vulnerable to wildfire. The Local Hazard Mitigation Plan identifies several critical water supply facilities that are in a high risk fire hazard zone: Montebello Reservoir, Corte Madera Reservoir and Booster Station, Park Reservoir and Booster Station, Boronda Reservoir and Booster Station, Quarry Booster Station, and Page Mill Turnout.

Table 7-3.1 summarizes the primary vulnerabilities of the City's water security and supply infrastructure to climate change impacts including sea level rise and drought.

TABLE 7-3.1. Climate Change Vulnerability of Water Supply

Function	Systems and infrastructure that provide a clean, safe and reliable water supply for the City of Palo Alto.	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Regional water demand likely to spike due to irrigation demand and increased evaporation losses • Secondary impact of elevated fire risk may increase water demand for fire suppression	• Short-term water supply for potable needs and fire suppression
Precipitation	• Higher risk of fluvial flooding of critical drinking water facilities • Potential to interrupt power supply needed for water delivery	• Water supply infrastructure in Palo Alto flood plain including piping & distribution facilities, • Municipal groundwater wells • Recycled water: flooding could impact RWQCP ability to supply recycled water (#5 on map)
Drought	• Decrease in total precipitation, with decreased snowpack in Sierra, leading to Regional Water System (RWS) shortages • Longer periods of low flow condition can affect water quality • More vulnerability to	• Long-term water supply: during extended drought SFPUC's regional water system may be inadequate to supply Palo Alto, and may suffer decline in quality

	extreme heat event • Regional water demand will generally increase due to irrigation demand and increased evaporation losses • More extraction of local groundwater could deplete supply and cause land subsidence	
Wildfire	• Reservoir and water supply infrastructure at risk from wildfire; could disrupt supply and/or affect water quality • Water imported from Sierra Nevada Supplies is potentially vulnerable to water quality change from fire-induced erosion • Could disrupt infrastructure, or access to infrastructure through fire damage and fire-induced erosion	• Montebello Reservoir • Corte Madera Reservoir and Booster Station • Park Reservoir and Booster Station • Boronda Reservoir and Booster Station • Dahl Reservoir and Booster Station • Quarry Booster Station • Page Mill Turnout
Sea Level Rise	• Increased frequency and depth of coastal flooding of critical drinking water facilities • Increased potential for fluvial flooding due to reduced drainage to the Bay • Potential for saline intrusion to contaminate deep aquifer that provides emergency potable water supply. • Increased inundation and rising groundwater may limit access to facilities and pipelines for maintenance and operations; Inability to access valves and access manholes • Buoyancy and corrosion of	• Municipal Services Center (map #8) • Utility Control Center (map #6) • Utility Engineering Center (map #3) • Water supply infrastructure in Palo Alto flood plain including piping & distribution facilities, • Municipal groundwater wells • Recycled water: flooding could impact RWQCP ability to supply recycled water (map #5)

	pipes	

Wastewater Management (WW)

This functional asset category covers Palo Alto's wastewater collection and treatment infrastructure including the Regional Water Quality Control Plant (RWQCP) operations, sewerage, and outfalls.

The City of Palo Alto's Utilities Department (CPAU) provides wastewater collection, with treatment services provided by the Public Works Department, for the City and its sphere of influence (SOI). The CPAU oversees a wastewater collection system consisting of over 208 miles of sewer lines, while the Public Works Department oversees the treatment of approximately 3.4 billion gallons of wastewater per year.[42] The RWQCP is designed to have an average dry weather flow (ADWF) capacity of 39 MGD and an average wet weather flow capacity of 80 MGD. Average daily flow is 22 MGD.

Due to aging infrastructure and the need for more informed financing and operations decisions, in 2012 the Palo Alto City Council approved a Long Range Facilities Plan for the RWQCP, which guides capital reinvestment, wastewater treatment services for six agencies, and ensures ongoing water quality control to protect the San Francisco Bay and local creeks.

The Local Hazard Mitigation Plan identifies the RWQCP and Utility Engineering Center as being at risk from mid-century sea level rise (16 inches), while the Utility Control Center and the Municipal Services Center are at risk from end-of-century sea level rise (55 inches). Figure 6.6 also shows these assets are at risk from sea level rise and associated flooding.

TABLE 7-3.2. Climate Change Vulnerability of Wastewater Management

Function	Systems and infrastructure that enable the City to reliably collect and treat its wastewater to a minimum standard for protecting public and ecosystem health.	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• None identified	• None identified
Precipitation	• Increased stormwater inflow into wastewater collection system • Localized flooding of RWQCP works from direct precipitation • Storms could knock out power to RWQCP	• RWQCP operations (map #5) • RWQCP peak treatment capacity

[42] City of Palo Alto, 2014. *Utilities at a Glance.* http://www.cityofpaloalto.org/civicax/filebank/documents/16777 , accessed December 8, 2014.

Drought	• None identified	• None identified
Wildfire	• Could knock out power to RWQCP	• RWQCP operations
Sea Level Rise	• Increased frequency and depth of coastal flooding of critical wastewater treatment facilities (RWQCP) • Increased inundation and rising groundwater may limit access to facilities and pipelines for maintenance and operations; Inability to access valves and access manholes • Buoyancy and corrosion of pipes • Peak discharge trough outfall could be reduced • Short-term flooding can disrupt biological treatment processes	• RWQCP operations o Flooding of below-grade joint interceptor sewer and galleries o Outfall pumping • Wastewater transmission pipes east of Bayshore Freeway.

Stormwater Management (SW)

This functional asset category includes the City's stormwater facilities and drainage systems. As explained in the Comprehensive Plan Update Draft Existing Conditions Report for Utilities and Service Systems, the City owns and maintains a municipal storm drain system consisting of approximately 107 miles of pipeline and 2,750 catch basins, 800 manholes and 6 pump stations. The City's storm drain pipe systems are designed for a 10-year return 6-hour storm event and the hydrology and hydraulics design criteria conform with the Santa Clara County Storm Drainage Manual.

The Local Hazard Mitigation Plan identifies several critical stormwater-related facilities at risk from mid-century sea level rise (16 inches): the Utility Engineering Center and the Adobe, Colorado, Matadero, and San Francisquito pump stations. The LHMP identifies the Utility Control Center, the Municipal Services Center, and the Airport Pump Station as being at risk from end-of-century sea level rise (55 inches). Figure 6.6 also shows these assets are at risk from sea level rise and associated flooding.

Flooding exposure can be mitigated with permeable surfaces that allow stormwater to infiltrate into soils instead of contributing to surface drainage, or watershed detention basins that retard stormwater flow or allow it to infiltrate.

TABLE 7-3.3. Climate Change Vulnerability of Stormwater Management

Function	Collect stormwater in piped networks and open channels and transport it to open water discharge sites as quickly as possible, without harming the receiving body of

	water	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• None identified	• None identified
Precipitation	• Increased discharge to stormwater system • Fluvial flooding can damage stormwater infrastructure	• Overall capacity of stormwater system, including the Palo Alto Flood Control Basin • Pump stations in flood prone areas: Adobe (#1 on map); Airport (#2); Colorado (#4), Matadero (#17), and San Francisquito (#66).
Drought	• None identified	• None identified
Wildfire	• Increased sediment from fire-damaged areas can impede drainage; increase maintenance	• Capacity of stormwater drainage system
Sea Level Rise	• Increased potential for stormwater and fluvial flooding due to reduced drainage to the Bay • Increased frequency and depth of coastal flooding may damage stormwater infrastructure.	• Overall capacity of stormwater system, including the Palo Alto Flood Control Basin • Pump stations in flood prone areas: Adobe (#1 on map); Airport (#2); Colorado (#4), Matadero (#17), and San Francisquito (#66).

Transportation Infrastructure (TI)

This functional category encompasses the City's major transportation infrastructure including state and federal highways, local arterials and access roads, bridges, railways, pedestrian pathways and bikeways, and the Palo Alto Airport.

Major highways located in the City or serving the City include: Interstate 280; US Route 101 (Bayshore Freeway); State highway 84 (Dumbarton Bridge/Woodside Road) and 82 (El Camino Real); County highways G3 (Page Mill Road/Oregon Expressway) and G5 (Foothill Expressway). Primary local roads include Embarcadero Road, Middlefield Road, Alma Street, Page Mill Road and Arastradero Road.

Caltrain, Santa Clara Valley Transportation Authority (VTA), San Mateo County Transit District (SamTrans), and AC Transit (Dumbarton Express) all provide service to and from Palo Alto. The Palo Alto Transit Center, located on University Avenue between El Camino Real and Alma Street, is the regional transit hub for the City, providing connections to neighboring communities and the wider Bay Area. Caltrain provides commuter rail service along Alma Street with stations at Palm Drive and California Avenue. VTA operates 14 bus routes in Palo Alto, providing connections to VTA light rail, Caltrain, Altamont Corridor Express (ACE) and AMTRAK Capitol Corridor. Stanford University Parking and Transportation Services operates a free public shuttle service connecting the campus to nearby transit, shopping, dining, and entertainment.

Many significant transportation assets that serve Palo Alto and the surrounding region do not have adequate alternatives in the case of flooding or other emergencies that put them out of commission. For example, disruption of State Highway 101, or the Highway 84 approach to the Dumbarton bridge, would result in heavy congestion that could overwhelm not only the City of Palo Alto but also the region as a whole. The Palo Alto Airport, the Municipal Services Center, and the Utility Control Center, as well as local access roads these facilities, are located in a major flood zone. Disruption to the road network will also affect public transportation, both directly for bus service and indirectly for CalTrain. The lack of adequate alternatives could leave Palo Alto residents isolated during emergencies or disasters.

Figure 6.6 shows the portion of Highway 101 between the Oregon Expressway and San Antonio Way, along with the approaches to the 101 overpasses at those two points, is at high risk from inundation due to sea level rise and storm surge by mid-century. Figure 7.1, from the Draft Silicon Valley 2.0 Climate Adaptation Guidebook, shows a number of bridges (including elevated roadways crossing Highway 101) in this area are vulnerable to sea level rise and storm surge by mid-century, primarily because the approached to these bridges, not necessarily the bridges themselves, would be inundated.

Figure 7.1: Bridge Assets Vulnerable to Sea Level Rise and Storm Surge, Mid-Century (from Silicon Valley 2.0)

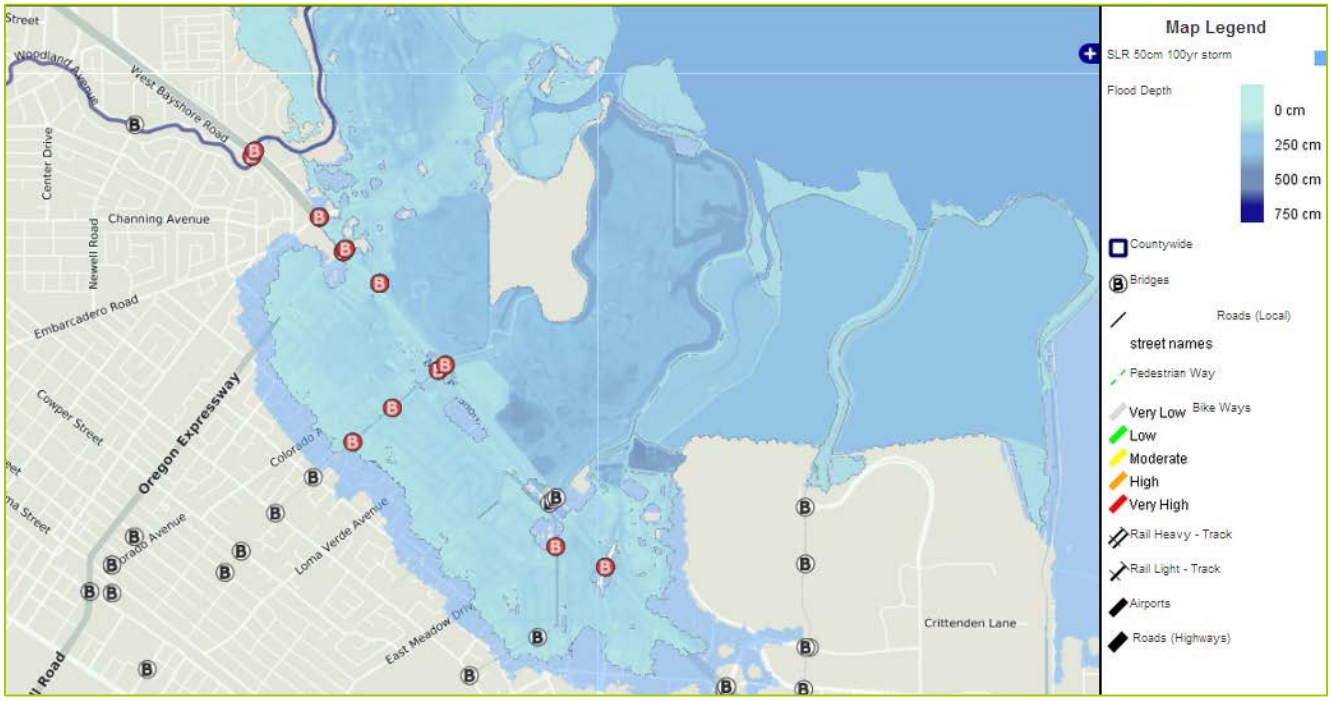


TABLE 7-4. Climate Change Vulnerability of Critical Transportation Infrastructure

Function	Provide mobility and access to support safety, security, and prosperity	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Roads: Can buckle, deform, soften pavement • Rail: extreme heat stresses materials and can buckle rails • Control and communication systems can overheat	• Local streets, highways • CalTrain railway
Precipitation	• Fluvial flooding of low-lying transportation infrastructure – erosion and other damage (exacerbated by sea level rise) • Increased precipitation increases surface water on roads	• Highway 101 and associated approach roads to overpasses • Surface streets in Palo Alto Flood Plain • Bicycle and pedestrian ways in Palo Alto floodplain • Palo Alto airport

Drought	• None identified	• None identified
Wildfire	• Fire damage to roads and highways	• Roads and highways in high risk fire zones include Skyline Boulevard (Highway 35), Page Mill Road, and smaller roads west of I-280
Sea Level Rise	• Increased frequency and depth of coastal flooding • Increased potential for fluvial flooding due to reduced drainage to the Bay • Erosion and other damage during storms	• Highway 101 and associated approach roads to overpasses • Surface streets in Palo Alto floodplain • Bicycle and pedestrian ways in Palo Alto floodplain • Palo Alto airport

Shoreline Flood Management (SF)

This functional asset category includes the ad hoc system of levees, landfill, and salt pond embankments, as well as tidal marsh wetlands that provide flood mitigation for the City's shoreline. Although these features do not provide a level of flood protection sufficient for FEMA certification, they do prevent flooding of developed areas along the shoreline for some coastal scenarios.

The shoreline flood management system is deficient relative to FEMA certification standards for levee crest elevation. This implies that the levees are at risk of being overtopped by the 100-year Bay water levels, thereby failing to prevent inundation on the landward side. Sea level rise, which may cause the present 100-year water level of 11.0 ft NAVD to be exceeded annually by a King Tide by end-of-century, will worsen this deficiency of the flood management system. The existing levees are also deficient relative to geotechnical and erosion protection criteria. Sea level rise will increase the geotechnical and erosion forces that the levees face, which makes levee failure more likely. A failed levee would further reduce flood protection, enabling overtopping to occur at lower elevations and greater rates.

Tidal marsh wetlands front portions of the City's coastal levees. In these locations, the marshes provide the ecosystem services of buffering wave heights and erosion. As such, the marshes contribute to the 'horizontal levee' system reducing coastal flood risk (ESA PWA, 2013[43]). Toward the end of the century, these marshes may not be able to independently sustain their elevation relative to

[43] ESA PWA. 2013. Analysis of the Costs and Benefits of Using Tidal Marsh Restoration as a Sea Level Rise Adaptation Strategy in San Francisco Bay. Prepared for The Bay Institute.

sea level rise and may convert to mudflat (Stralberg et al., 2011[44]). Loss of the tidal marsh vegetation would expose the shoreline levees to greater risk of failure.

At this time, there is not enough information about the potential changes of climate change on regional storm intensity and frequency nor have the local effects of different storm conditions been assessed. The GCMs currently forecast limited change to increase in peak precipitation (see Section 0), which is an indicator of storm intensity. Given this lack of information and relatively small liklihood of change in related processes, the effects of more intense storms on the shoreline management system are noted in Table 7-5, but not included in the adaptation strategy assessment (Section 8).

TABLE 7-5. Climate Change Vulnerability of Shoreline Flood Management

Function	Provide flood protections for the Palo Alto shoreline along San Francisco Bay	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• None identified	• None identified
Precipitation	• Erosion of levees and wetlands from increased wave forces • Breaching and overtopping of levees	• Integrity of flood risk management levees • Integrity of Palo Alto Flood Basin • Fluvial storage capacity of Palo Alto Flood Basin
Drought	• None identified	• None identified
Wildfire	• None identified	• None identified
Sea Level Rise	• Increased frequency and depth of coastal flooding during storms • Long-term increase in overtopping of coastal levees • Increased erosion of levees and wetlands	• Overall shoreline flood management capacity • Integrity of flood risk management levees • Integrity of Palo Alto Flood Basin • Functioning of Palo Alto Flood Basin o Reduced capacity to drain by gravity

[44] Stralberg, Diana, Matthew Brennan, John C Callaway, Julian K Wood, Lisa M Schile, Dennis Jongsomjit, Maggi Kelly, V Thomas Parker, and Stephen Crooks. 2011. "Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay." PloS One 6 (11) (January): e27388. oi:10.1371/journal.pone.0027388.

		o Coastal flooding

Public Health (PH)

This functional asset category covers the health-related impacts of climate change, with a special focus on the City's populations who are most vulnerable those impacts, including those with special needs, living in poverty, or most exposed to the physical impacts of climate change.

The City's more vulnerable populations (elderly, impoverished, non-English-speaking, or physically incapacitated) face climate-related public health risks associated with heat-related illness and mortality, respiratory impacts, infectious diseases, and changes in socioeconomic conditions that may impact well-being. Extreme heat and precipitation events, diminished air quality (e.g., high ozone levels), new disease vectors, and food insecurity all represent potential health and safety risks. Outdoor workers, in particular, are vulnerable to extreme heat and weather events. [45] Particular concern centers on the increasing tendency for multiple hot days in succession, and heat waves occurring simultaneously in several regions throughout the state, which could affect power reliability. The City's vulnerable populations may require special response assistance or special medical care after a climate-influenced disaster. Physically vulnerable areas of the City (e.g., low-lying areas prone to flooding) that overlap with high-density residential or commercial development could experience high death tolls and injury rates from extreme weather events.

According to the 2010 U.S. Census, Palo also had 17.1% of residents over the age of 65, compared to 11.4% for the state of California. 5.7% of City residents are living below the Federal Poverty Level, compared to 15.9% statewide. [46] A map published by the Santa Clara County Public Health Department shows lower-income residents (defined as living at or below 200% of the Federal Poverty Level, which was approximately $22,000 for a family of 4 in 2010) concentrated in the northern portion of the City bounded by University, Middlefield, Lincoln, and Alma streets, and in a smaller area bordering the City of Mountain View north of El Camino Real.[47]

The CalEnviroScreen 2.0 tool uses a science-based method for evaluating multiple pollution sources in a community while accounting for a community's vulnerability to pollution's adverse effects. The tool can be used to identify California's most burdened and vulnerable communities. The tool presents a broad picture of the burdens and vulnerabilities different areas confront from environmental pollutants. It relies on the use of indicators to measure factors that affect pollution impacts in communities. CalEnviroScreen identifies vulnerable communities in California most burdened by pollution from multiple sources and most vulnerable to its effects, taking into account their socioeconomic characteristics and underlying health status. These same communities are typically those most sensitive to climate change exposure, including extreme heat events, enduring heat waves, sea level rise, extreme storms, diminished air quality, and new disease vectors. CalEnviroScreen provides relative scores (percentiles) indicating population vulnerability with Higher scores indicating areas with highest pollution burdens and most sensitive populations.

CalEnviroScreen shows the area of the City east of Highway 101 (census tract 6085504601 with a population of 817) as having a relatively high score of 71 to 75%, driven by high exposures to traffic

[45] Drechsler, D. M. 2009. *Climate Change and Public Health in California.*

[46] U.S. census website, accessed 12/22/14: http://www.census.gov/acs/www/

[47] Santa Clara County Public Health Department, 2013. *Community Health Existing Conditions Report*. Figure 2-10: Vulnerable Communities – High Proportions of Low-Income Residents

density, and potential exposures to impaired surface and groundwater, hazardous/toxic waste, and solid waste. The demographic stressors for this area include relatively high unemployment, relatively older population and relatively low education. Notably, CalEnviroScreen vulnerability scores are relatively low for the low-income areas identified by the County Public Health Department.

The Draft Existing Conditions Report for the Palo Alto Comprehensive Plan Update[48] reports that the percentage of Palo Alto residents living in poverty declined in 2012 for the first time since the 1980s, while the proportion of households below the poverty level in Santa Clara County continued to rise.

TABLE 7-6. Public Health: Vulnerability to Climate Change

Function	Organized community efforts aimed at the prevention of disease and the promotion of health, for the population as a whole	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• More frequent and severe heat waves lead to death and illness, increased air pollution and fires, and greater risk of food and water contamination • Increase in average temperatures leads to more air pollution and greater risk of new pests and diseases • Increasing temperatures, drought, severe storms and invasive species all increase the risk and severity of wildfires	• The City's most vulnerable residents are at risk of health emergencies or longer-term adverse health effects.
Precipitation	• More frequent or more powerful storms disproportionally impact public safety of vulnerable populations, especially those in low-lying areas • Extreme storms challenge emergency response actions,	• Residents, workers and schoolchildren in the Palo Alto Flood Plain, east of highway 101.

[48] City of Palo Alto, 2014, Draft Existing Conditions Report: Population, Housing and Employment. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 22, 2014.

	overburden stormwater management systems, and increase risk of vector-borne disease • Extreme storm could cause flooding of RWQCP outfall and influent pump station, disrupting wastewater treatment operations; potential sewer overflow into Bay creates health risk.	
Drought	• Less local rainfall and diminished Sierra snowpack jeopardizes reliability and quality of potable water supply	• Potable water quality and reliability for entire City
Wildfire	• Smoke from wildfires impacts air quality and respiratory health of vulnerable populations • Displacement and loss of homes and jobs places disproportionate burden on low-income or impoverished populations	• Residents and workers at risk from fire hazards and smoke inhalation along the urban-wildfire interface • The City's elderly, youth, and health-compromised at risk from fire-impacted air quality
Sea Level Rise	• More frequent and deeper flooding threatens safety and health of vulnerable populations living in low-lying areas • Inundated or saturated areas are potentially at higher risk of liquefaction during earthquakes	• Residents, workers, and schoolchildren in flood prone areas, east of 101.

Buildings and Property (BP)

This functional asset category includes residential and commercial private property, including homes, businesses, commercial and industrial buildings, schools, government buildings, parks and recreation

areas, and other property assets. Palo Alto also has many important historical and cultural assets that are potentially vulnerable to climate change impacts.

Palo Alto is a relatively wealthy community with high significantly higher property values than the rest of the region. The Draft Existing Conditions Report for the Palo Alto Comprehensive Plan Update[49] notes that the median household income in Palo Alto in 2012 was $122,482, while the median home price for single-family residences and condominiums in Palo Alto was $1,720,000 in 2013, up 15 percent from 2012, more than 2.5 times that of the County median price of $645,000. Residential land uses make up approximately 27 percent of the total land area within the City limit. As shown on the Comprehensive Plan Land Use Map (Appendix A), residential land use is primarily located in the urbanized portion of the city between El Camino Real and Highway 101, the neighborhoods west of El Camino Real and south of the Stanford University campus, and areas west of I-280 bordering the town of Los Altos Hills. As shown in Figure 6.6, the residential area bound roughly by Highway 101, Middlefield Road, Embarcadero Road, and Charleston Road is at risk from sea level rise by 2050, with the at-risk area slightly expanded by 2100. These properties, as well as properties in the vicinity of San Francisquito Creek, are also in the FEMA 100-year flood zone. As shown on Figure 6.5, residential properties west of Interstate 280 bordering Los Altos Hills, as well as multifamily residential properties along Sand Hill Road, are at moderate to high risk of exposure to wildfire.

According to the City of Palo Alto web site, Palo Alto is home to more than 7,000 businesses that employ more than 98,000 jobs.[50] With its location in Silicon Valley and proximity to Stanford University, the City has long been an engine of entrepreneurial growth, spawning many high profile firms including Xerox, Hewlett-Packard, Google, Facebook, PayPal, Tesla Motors. Stanford Research Park on Page Mill Road is the home to many prominent technology firms. Business, commercial, and industrial land uses make up approximately 10 percent of the total land area within the City limit. The largest business park in Palo Alto is the 10 million-square-foot Stanford Research Park., while the largest commercial area in the City is the approximately 1.4 million- square-foot Stanford Shopping Center. As shown on the Comprehensive Plan Land Use Map (Appendix A), extensive commercial and industrial properties exist in low-lying areas along Highway 101 and east of 101 in the PAFB, where they are vulnerable to sea level rise and flooding. Commercial and industrial properties along Sand Hill Road are at moderate risk from exposure to wildfire, as indicated on Figure 6.5.

Parks and open spaces uses account for nearly 59 percent of the total land area within the City limit. A map from the Palo Alto Parks, Trails, Open Space and Recreation Master Plan[51] (Appendix A) indicates that most of these areas are located in the hills west of Foothill Expressway and in the Palo Alto baylands east of Highway 101. As with the private property described, low-lying park areas along the Bay are vulnerable to flooding and sea level rise, while parks in the foothills are at risk from wildfire. In 2014, the City of Palo Alto initiated a planning process to analyze and review Palo Alto's park and recreation system and prepare a Park and Recreation Master Plan to guide future renovations and capital improvements for parks, trails, open space, and recreation facilities. The Master Plan will

[49] City of Palo Alto, 2014, Draft Existing Conditions Report: Population, Housing and Employment. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/ , accessed December 22, 2014.

[50] Palo Alto Business Facts: http://www.cityofpaloalto.org/news/displaynews.asp?NewsID=592&TargetID=52 , accessed December 23, 2014.

[51] City of Palo Alto Parks, Trails, Open Space and Recreation Master Plan, http://www.paloaltoparksplan.org/pdf/Parks-Map.pdf, accessed from City web site on December 23, 2014.

prioritize short term (5 years), mid-term (10 years), and long-term (25 years) improvements. It is anticipated that a final report will be presented to the City Council in fall 2015.[52]

Palo Alto is home to many public schools, private schools, charter school, libraries, and institutes of higher education including the venerable Stanford University located adjacent to the City. According to the City's Draft 2014 Comprehensive Plan, the Palo Alto Public School District (PAPSD) operates 13 elementary schools, 3 middle schools, and 2 high schools across an area that covers the City of Palo Alto as well as portions of the town of Los Altos and portions of Portola Valley and the Stanford University campus. Foothill-De Anza Community College is based in neighboring Los Altos Hills and has campus within Palo Alto located at the Cubberley Community Center, which serves about 3,500 students. Other universities, technical and specialty schools located in the City include: Palo Alto University including the Pacific Graduate School of Psychology, Sophia University (formerly the Institute of Transpersonal Psychology), and the Bay Area College of Nursing. Palo Alto Unified School District facilities most at risk from flooding due to storms and sea level rise include Ohlone Elementary School, Palo Verde Elementary School, and Jordan Middle School. Duveneck Elementary School faces longer-term risk from sea level rise, but is located in the FEMA 100-year flood zone.

To mitigate serious wildfires at the urban interface the State Fire Marshal included adoption of Chapter 7A in the California Building Code, requiring fire resistant exterior construction in hazardous fire areas. The City of Palo Alto has adopted these requirements for new construction or significant remodels in the moderate to high fire hazard severity areas in Palo Alto, as defined by CalFire.[53] This includes most of the City's land southwest of Foothill Boulevard and the area around the RWQCP. The City building code has also required fire sprinklers in new buildings and significant remodels in these areas since 1994.

TABLE 7-7. Climate Change Vulnerability of Buildings and Property

Function	Provides the fabric of urban living, supporting the physical, financial, recreational, and emotional well-being of the community.	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Heat damage to asphalt • Stress capacity of building cooling systems	• Asphalt parking lots, driveways, private roads • Ability of HVAC systems to provide adequate cooling
Precipitation	• Increase in erosion events • Localized flooding	• Buildings and property in flood zones

[52] City of Palo Alto, 2014, Draft Existing Conditions Report: Recreation. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/, accessed December 22, 2014.

[53] Cal Fire Fire Hazard Severity Zones Maps: http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_zones.php

Drought	• Increased need for irrigation	• Local trees and landscaping; urban forest
Wildfire	• More frequent and higher intensity wildfires	• Private homes and businesses in high risk fire zones • Parks, trails, open space and recreation areas west of Foothill Expressway
Sea Level Rise	• Increased frequency and depth of coastal flooding • Increased potential for fluvial flooding due to reduced drainage to the Bay • Inundated or saturated areas are potentially at higher risk of liquefaction during earthquakes	• Buildings and other property in the Palo Alto floodplain • Baylands recreation areas (e.g., golf course, trails, nature center)

Solid Waste/Hazardous Materials Management (SM)

The Palo Alto Landfill located east of Highway 101 has been closed since February 2012. The City plans to have the landfill 100% capped by the summer of 2015. The landfill has a landfill gas and leachate collection system in place along with an incinerator for flaring the collected methane. The highest elevation of the landfill is approximately 60 feet above mean sea level. The landfill's lower elevations including the road going around it are susceptible to flooding and erosion from sea level. The City expects the landfill to settle and subside for another 20 years, approximately. Flooding could damage or disrupt the landfill gas and leachate recovery operation.

GreenWaste of Palo Alto, a joint venture between GreenWaste Recovery, Inc. and Zanker Road Resource Management, Ltd., currently holds the City's contract for the collection and transportation of municipal solid waste, commercial organics, residential yard trimmings. All solid waste and recyclables, including construction and demolition debris, are trucked out of the City and processed at facilities elsewhere. Two of those facilities, the Zanker Material Processing Facility for processing of construction and demolition debris, and the Sunnyvale Materials Recovery and Transfer Station (SMaRT Station) for processing of municipal solid waste (MSW), are located in low-lying areas near the bayshore in San Jose. These facilities are at risk from Sea Level Rise and coastal flooding.

Several areas of soil and groundwater contamination exist as a legacy of past practices at Stanford Research Park, but these areas to the west of El Camino Real are not vulnerable to sea level rise or climate-related impacts.

The City's Household Hazardous Waste (HHW) drop-off station is located at the RWQCP. Hazardous materials could be at risk of entering the environment in the event of an extreme flood.

TABLE 7-8. Climate Change Vulnerability of Solid Waste/Hazardous Materials Facilities

Function	Control or manage solid waste and hazardous materials disposed of by the community	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• None identified	• NA
Precipitation	• Increased erosion potential	• Capped landfill
Drought	• None identified	• NA
Wildfire	• None identified	• NA
Sea Level Rise	• Increased frequency and depth of coastal flooding • Increased potential for fluvial flooding due to reduced drainage to the Bay	• Erosion of levees protecting landfill • Inundation of landfill gas collection system at capped landfill • Containment of contaminated soils and groundwater

	• Increased erosion potential • Changes to groundwater elevations, gradients, and transport rates	• Household Hazardous Waste Facility • GreenWaste Facility • Municipal Service Center

Natural Areas, EcoSystems (NE)

This functional asset category includes natural areas and ecosystems that are critical to local flora and fauna, as well as ecosystem services (e.g., flood control, wave surge protection, erosion control, nutrient retention, water quality improvement) provided by the City's natural areas.

Palo Alto's boundaries extend from the San Francisco bay to the Santa Cruz mountains, encompassing several microclimates and natural habitats. Undeveloped lands in the Baylands and in the western hills contain undisturbed plant communities that support a variety of species. The natural vegetation has been substantially altered in the developed areas of the city, leaving the urban forest as the dominant habitat. Some of the stream corridors in the developed portions of the city also support natural vegetation. The primary natural habitats found along the Bay include coastal saltwater/brackish marsh, freshwater marsh, and valley foothill riparian, while the foothills west and southwest of downtown support grasslands, coastal oak woodlands, coastal scrub, redwood forest, and montane hardwood and conifer forests.[54]

The Draft Palo Alto Urban Forest Master Plan[55] lists more than 300 species of street trees in Palo Alto, with the following five species representing almost 35 percent of the total trees planted: southern magnolia, London plane, American sweetgum, Modesto ash, and camphor. The urban forest, which provides cover, forage, and nesting habitat for common wildlife as well as a buffer against the heat island effect during periods of high temperature, is well established in the older parts of the city, where mature street trees provide a dense canopy. The Draft Urban Forest Master Plan provides an in-depth management plan for the City's street trees as well as its urban forest, encompassing the area between Highways 101 and 280 as well as the Municipal Golf Course and a small area west of 280 that includes a single-family neighborhood zoned Residential Estate (RE). Public Works has recently updated the approved street tree list in anticipation of climate change impacts including longer periods of drought and more limited water supplies for irrigation. Coast redwoods are no longer approved, and the City is in the process of identifying more drought-tolerant species that are appropriate for Palo Alto and can tolerate higher salinity water, to allow more use of recycled water for irrigation needed in early growth stages.

Silicon Valley 2.0, the regional adaptation planning effort, assesses the climate change vulnerability of 11 distinct natural habitats in Santa Clara County. Temperature increases are expected to impact all habitats in Santa Clara County, through decreases in soil moisture, heat stress, disruption of periodic biological phenomena (phonologic cycles), more invasive species, more competition for freshwater resources, and loss of food supply. Changes in precipitation patterns could intensify competition for freshwater resources, and stress natural habitats with increases in wildfire, landslide, and erosion. Reduced or altered vegetation coverage, in combination with heavy precipitation events, results in more runoff, increased erosion and sedimentation, which in turn impact water quality and sensitive aquatic and riparian habitats. Riverine flooding can also impact aquatic and riparian habitats. Drought conditions and higher temperatures increase the risk of wildfires, which alter habitats and ecosystem services. Burned areas are susceptible to increased erosion, flooding, and landslides. [56]

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[54] City of Palo Alto, 2014, Draft Existing Conditions Report: Biological Resources. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/, accessed January 2, 2014.

[55] City of Palo Alto Department of Public Works: Urban Forestry Division, 2014, *Sustaining the Legacy: Palo Alto Urban Forest Master Plan (Draft),* available at: http://www.cityofpaloalto.org/civicax/filebank/blobdload.aspx?BlobID=36187

[56] Santa Clara County Office of Sustainability, 2014.

In general, sea level rise will alter existing intertidal, wetland, and coastal habitats through inundation, storm effects, and saltwater intrusion. The flood protection and water quality services provided by marshes and wetlands will also be diminished.

In 1978, the City of Palo Alto adopted the Baylands Master Plan[57] with the goal of balancing ecological preservation with continued commercial and recreational use of the Palo Alto Baylands. The Baylands Master Plan was updated in 1988 and again in 2008. Today the Baylands offers a wide range of recreational opportunities, including recreational flying, golfing, and team sports played at the popular Athletic Center.[58]

The City of Palo Alto is currently preparing a Parks, Trails, Open Space and Recreation Master Plan to manage, improve and expand its parks and recreational facilities, while ensuring that the open-space and conversation needs of future generations are appropriately balanced and adequately funded. The expected climate change exposures to natural landscapes and ecosystems should be fully incorporated into this long term management plan.

TABLE 7-9. Climate Change Vulnerability of Natural Areas, EcoSystems

Function	Provide habitat to local flora and fauna and ecosystem services for community well-being	
Exposure	**Potential Impacts**	**Assets at Risk**
Temperature	• Extreme hear and overall higher temperatures can decrease soil moisture, increase evaporation, increase heat stress at individual and population scales, disrupt phonologic cycles, increase invasive species, increase competition for freshwater resources, and impact food supply.	• Uplands habitats • Urban forests • Redwood forests
Precipitation	• Increase in erosion events and sediment loss	• Loss of wetland areas due to wave erosion • Water quality in local streams and reservoirs •

[57] City of Palo Alto Department of Planning and Community Environment, October, 2008: Baylands Master Plan, 4th Edition.

[58] City of Palo Alto, 2014, Draft Existing Conditions Report: Recreation. http://www.paloaltocompplan.org/resources/draft-existing-conditions-report/, accessed December 22, 2014.

Drought	• Stress to local flora and fauna, natural habitats	• Baylands habitats • Urban forest; local trees & vegetation providing habitat • Redwood forests •
Wildfire	• Loss of natural habitat • Fire makes forested areas more vulnerable to storm-induced erosion and sediment loss	• Forested areas in high fire risk areas, including Foothills Park and Pearson-Arastradero Preserve • Water quality in local streams and reservoirs
Sea Level Rise	• Increased inundation of Baylands marshes leading to drowning and loss of marsh vegetation. • Fragmentation of wetlands • Loss of high tide refugia for dependent species • Inundation and erosion of parklands	• Drowning of Bay marshes • Baylands habitats and biodiversity • Baylands ecosystem services (e.g., water quality, erosion protection, aesthetics etc.) • Palo Alto Baylands Park and the future landfill park conversion

Assessing Risk and Prioritizing Adaptation Responses

Risk and Response Framework

This chapter presents a framework for assessing risk and prioritizing adaptation responses using the following steps:

1. Assess the risk associated with the City's asset vulnerabilities that were identified in the previous chapter;
2. Identify existing plans and measures currently in place at the City that involve that asset and/or provide adaptive capacity to the vulnerability; and
3. Identify response(s) needed in the next phase of City planning to improve resiliency of that asset.

Risk Assessment

Climate risk is commonly described as the likelihood and consequence of a climate variable's impact on a vulnerable asset. Risk ratings consider the certainty of the science associated with each climate variable as well as consequence of failure concerning the asset. Due to the inherent uncertainty of the timing and severity of climate change impacts it is often difficult to assess the likelihood of a particular asset being affected within a certain timeframe, so in many cases the evaluation of consequence was the most important component in assessing risk. Some helpful questions used to asses risk include the following:

- What is the age, condition, or useful remaining life of the asset?
- If impacted, could the asset be repaired or would it require complete replacement?
- What would it cost to repair or replace the asset?
- Would asset failure or incapacity disrupt a critical service? If so, how long could the disruption last? Is there a redundant systems or service that is less vulnerable?
- What are the economic, health, and/or safety costs associated with a disruption in service?

A broad, high-level risk assessment was performed for the asset vulnerabilities identified in Chapter 7. The results are presented in the City of Palo Alto Risk and Response Matrix in Appendix D, Organized by functional category, the Risk and Response Matrix presents a "heat map" showing relative risk to each asset from each of the five main climate exposures described in Chapter 6, using colors to indicate the following:

	significant risk increase compared to existing conditions
	moderate risk increase compared to existing conditions
	minor risk increase compared to existing conditions
	no identified risk increase compared to existing conditions

The colors are used to represent the risk of climate-related impacts occurring over near-term (to 2050) and longer-term (to 2100) planning horizons. In general, highly vulnerable assets with high costs of failure or disruption are associated with highest risk, and the risk increases with time along with the expected increase in severity of climate change impacts.

Existing Adaptive Measures

Identifying appropriate response actions requires first understanding existing conditions in terms of plans, policies, and programs that concern the asset being evaluated. In the Risk and Response Matrix, a column lists relevant plans and programs that are currently providing or addressing adaptive capacity concerning the asset. Plans and programs may be local, regional, state, and/or national. For example, the City's capability to manage peak stormwater flow is addressed in multiple local plans and programs, including the Local Hazard Mitigation Plan and the Storm Drain Master Plan; the City also participates in relevant regional and national programs (e.g., Santa Clara Basin Watershed Management Initiative, and the National Flood Insurance Program).

Recommended Responses

Recommended adaptation response actions concerning each asset are presented in four main categories, with colors to represent the following:

A	***Act:*** Defines actions that are known and required now to mitigate identified risks
P	***Prepare:*** Defines tasks to improve understanding of the cause or solution to a significant risk.
M	***Monitor***: Requires monitoring of latest climate science developments and local/regional situation
N	***No action*** needed

The following sections summarize significant risks and associated response actions recommended for each functional asset category.

Emergency Response and Communications (ER)

The City's Emergency Response and Communications assets most vulnerable to climate change include the Municipal Services Center (MSC) and Utility Control Center (UCC), which face moderate risk from sea level rise by 2050 and significant risk from sea level rise by 2100. Plans should be established to protect these assets, relocate them, or establish redundant operational capabilities in case these facilities become incapacitated during a flooding event.

Communication towers in the foothills also face significant risk from wildfire by 2100. These towers should be assessed for their vulnerability to wildfire including their criticality in the overall system, the consequences of failure. Emergency preparedness plans should be updated accordingly.

Energy Security and Infrastructure (ES)

Long-term changes in precipitation patterns caused by climate change represent significant risk to the availability of hydropower for the City, due to expected higher incidence of severe droughts, loss of Sierra snowpack, and wildfires. These risks could directly impact the stability of the California transmission grid, driving up loads and supply volatility. This volatility will also impact price volatility, which will likely increase the financial risks faced by the Utility and the Electric Enterprise Fund. The City needs to develop an energy resiliency plan focusing on building in resiliency and lessening the impact of statewide energy events. These measures should include islanding, smart grid, local generation, energy storage and redundant transmission lines.

The MSC, UCC, and Utility Engineering Center, which are all critical to energy operations, face moderate risk from sea level rise by 2050 and significant risk from sea level rise by 2100. Plans should

be established to protect these assets, relocate them, or establish redundant operational capabilities in case these facilities become incapacitated during a flooding event.

Water and Wastewater

Water Supply (WS)

The City's long-term water supply faces significant risk from loss of Sierra snowpack and drought by the year 2100. The City should continue aggressive water conservation programs, set higher conservation goals in the 2015 update to the Palo Alto UWMP, and continue to participate in in regional planning efforts by BAWSCA, SCVWD and SFPUC. Ongoing investigation of potential alternative supplies, including recycled water and use of local groundwater sources, should be continued.

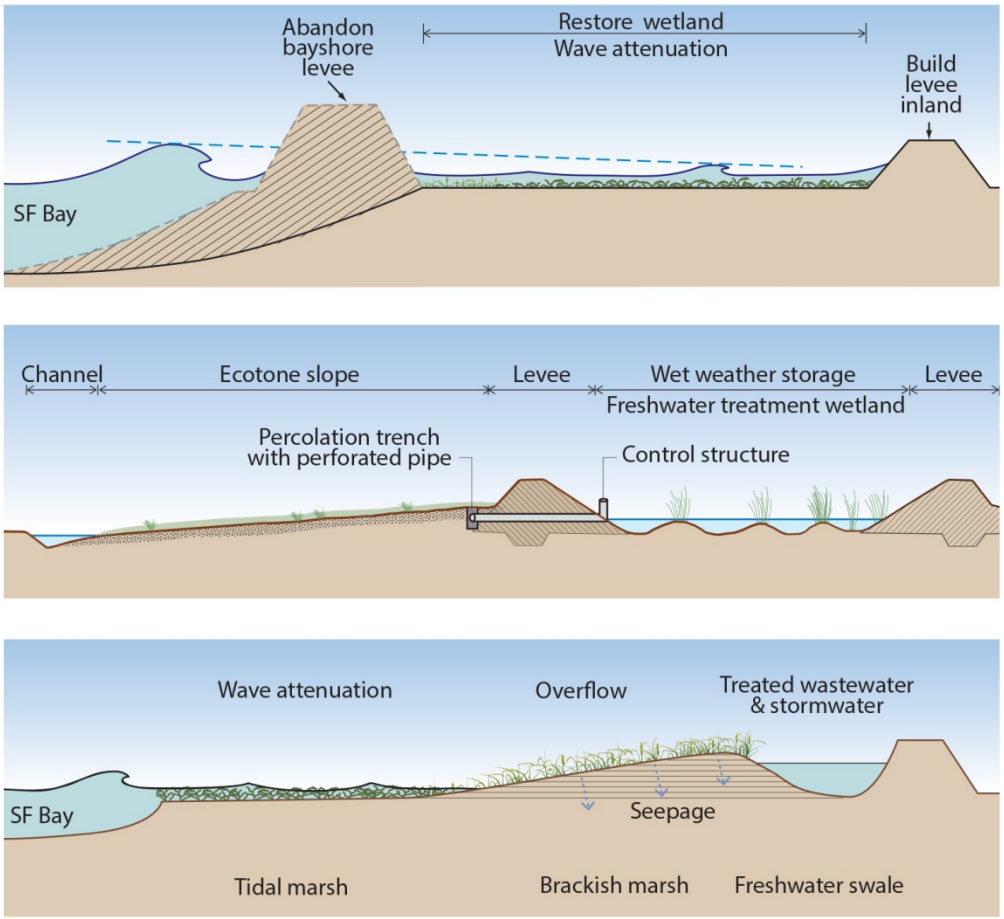
The MSC, UCC, and Utility Engineering Center, which are all critical to water operations, face moderate risk from sea level rise by 2050 and significant risk from sea level rise by 2100. Future recycling operations planned at the RWQCP, along with water supply infrastructure and municipal groundwater wells located in the Palo Alto flood plain, also face significant risk from sea level rise by 2100. Plans should be established to protect these assets, relocate them where possible, or establish redundant operational capabilities in case these facilities become incapacitated during a flooding event.

Wastewater Management (WW)

The greatest risk to the City's wastewater management is potential failure of existing levees that protect the RWQCP from coastal flooding associated with sea level rise by 2100. In addition to the SAFER Bay project that is planning coastal levee improvements there may be opportunities for incorporating treated wastewater effluent into future levees by creating ecotone slopes –"a horizontal levee" - bayward of the existing levee. Creating wider, shallower slopes in front of a traditional flood risk management levee would attenuate waves and reduce overtopping, resulting in the need for smaller levees. This would also recreate valuable upland habitat bordering the marshes that has long been missing from the Bay and provide space for marshes to migrate into with rising sea levels. In addition there are potential wastewater polishing benefits to this approach through denitrification and the removal of contaminants of emerging concern.

The horizontal levee approach is being investigated in the East Bay by a regional partnership including UC Berkeley and East Bay Dischargers Authority (EBDA), among others. Figure 8.1 provides a conceptual illustration of the demonstration project at Oro Loma Sanitary District, which is funded by the District and a $2.1 million grant from the Integrated Regional Water Management Program through the California DWR. The EBDA is conducting a parallel project to explore ways to redirect and decentralize discharge of treated wastewater effluent and put it to good use irrigating ecotone slopes, transitional habitats and buffer zones along the shoreline. These projects may lead to opportunities to decentralize discharges to the Bay, reduce nutrient loading in the Bay, and make better use of treated wastewater as an increasingly valuable freshwater resource. The City should track the progress of the Oro Loma and EBDA projects and consider a similar approach to integrating wastewater management with coastal flood management and habitat development.

Figure 8.1: Horizontal Levee Approach Proposed for Oro Loma Sanitary District



Options for more resilient levees, habitats and shoreline protection. Top: moving the levee inland and buffering it with a wetland; middle, elements of Oro Loma experiment; bottom; profile of possible future shoreline gradient from fresh to salt water habitats. Source: ESA

The City should study the feasibility of a flood proofing plan for the RWQCP that minimizes impacts to the RWQCP site in the event of local inundation. Though there is some increased risk to treatment plant capacity represented by extreme precipitation creating stormwater overflow that gets diverted to the RWQCP, the risk is low based on the relatively small changes predicted by the Global Climate Models (GCMs). For similar facilities in the Bay, direct precipitation onto the site may become a significant issue and cause localized flooding, exacerbated by the number of below grade galleries. This vulnerability was demonstrated at Rockaway WWTP during Hurricane Sandy where a few inches of surface flooding filled below-grade galleries that contained pumps, electrical control gear, spare parts and document storage areas. Floodproofing the below-grade galleries and removing non-essential items to higher locations could significantly reduce the impact.

As the sea level rises the required discharge pump head increases reducing the capacity of gravity and pumped systems. Similar pumped outfalls in the Bay are predicting 10-20% reduction in capacity as sea level rises over the next century, requiring either alternative discharge of peak flows, reduced output due to more recycling, or larger pump capacity.

Stormwater Management (SW)

With respect to stormwater management, the biggest risk facing the City is diminished capacity of the Palo Alto Flood Basin to retain stormwater during times of high tide, based on sea level rise projections out to 2100. To improve resilience, the City should coordinate creek flood management planning with the SAFER coastal flood management project that is just getting underway (see Section 4.5, and shoreline flood management discussion below). The horizontal levee concept described above has also been suggested as a way to divert flows from flood basins and accommodate them in a larger coastal floodplain. Integrating stormwater into the wetlands rather than segregating it in stormwater channels and detaining it in flood basins may create a more resilient shoreline by reestablishing sediment and freshwater pathways that allow wetlands to respond to sea level rise.

The City's Airport and San Francisquito stormwater pumping stations are at risk from sea level rise by 2100; Plans should be developed to protect these assets from flooding, or determine the consequences of their failure in the overall stormwater management system, in the event of flood.

Transportation Infrastructure (TI)

Highway 101 (Bayshore Freeway), the Palo Alto Airport, and surface streets in the Palo Alto floodplain are all at significant risk from sea level rise by the year 2100. Current levees are not likely to adequately protect these assets from sea level rise; the SAFER Bay project is planning improvements to these levees. As an intermediate measure, the City should develop contingency plans for temporary loss of these assets.

Many roads and highways in the foothills are in high risk zones for wildfires by the year 2100. The vulnerability of these assets should be better defined, along with consequences of failure and contingency plans in the event they become damaged or inaccessible.

Shoreline Flood Management (SF)

Sea level rise is the key climate change risk factor for shoreline flood management. At the end of 2014, the City began its participation in the SAFER Bay project to provide coastal flood improvements. The SAFER Bay project will develop a preferred alignment for the coastal flood protection. As part of this assessment, the SAFER project may consider different levee alignments. Possible areas for re-alignment include around the Palo Alto airport and around the Palo Alto Flood Basin (PAFB). Re-alignment landward would provide opportunities for restoring tidal marsh and/or marsh-to-upland ecotone on the outboard side. The SAFER project is just getting underway for the Palo Alto shoreline, so has not yet produced any specific plans or recommendations.

Both the airport and the PAFB have performance criteria which constrain re-alignment. Land to the east of the existing runway may be used for adding an additional runway in the future. However, the existing runway has length and clearance criteria set by FAA that may conflict with raising the levee elevation.

The PAFB provides storage capacity for Matadero, Barron, and Adobe Creeks. A recent report (Schaaf & Wheeler, 2014[59]) identifies existing deficiencies in the PAFB's storage capacity that worsen with sea level rise. Re-aligning the coastal flood levee landward would further reduce the PAFB's storage

[59] Schaaf & Wheeler. 2014. Palo Alto Flood Basin Hydrology. Prepared for Santa Clara Valley Water District.

capacity, but may cost less than constructing the coastal flood levee around the PAFB. Reduced storage capacity in the flood basin transfers additional flood risk upstream along the creeks. The flood basin also provides vegetated marsh habitat for endangered species and its water levels are managed to minimize mosquito breeding. The impacts of levee re-alignment on these habitats also need to be considered.

The City should consider how treated wastewater effluent and stormwater could be incorporated into the SAFER design (as described in Section 8.4.2 and 8.4.3 above) by decentralizing the discharge of treated wastewater and reconfiguring the detention of stormwater.

Public Health (PH)

The City's most vulnerable populations (elderly, low-income and health-compromised residents) face significant risk from extreme heat events by 2100. These populations will also face higher risk of health problems from worsening air quality and new disease vectors.

The following general response actions recommended to minimize public health risk from climate change impacts:

- Engage the public and promote community involvement in actions to reduce climate change risks, using linguistically and culturally appropriate approaches that are effective for diverse populations.
- Reduce urban heat islands (also has energy conservation/GHG co-benefit).
- Partner with organization like Cal-BRACE (Building Resilience Against Climate Effects) to forecast climate impacts and assess public health vulnerabilities, educate and engage more effectively with the community, assess current strategies, and identify effective responses.
- Engage with and seek support from Association of Bay Area Government's (ABAG) community resilience programs; in particular their multiple hazard risk assessment and study of housing resilience in the face of natural disasters.

The following resources are available for Public Health planning and developing public health programs related to climate change:

- CalEnviroScreen helps identify California communities that are disproportionately burdened by multiple sources of pollution.
- Cal-BRACE (Building Resilience Against Climate Effects): The goals of the CalBRACE project are to enhance the California Department of Public Health's (CDPH) capability to plan for and reduce health risks associated with climate change. The program provides resources and technical assistance for the state and local public health departments to build climate adaptation capacity and enhance resilience at the local and regional levels. CalBRACE is funded by the Center for Disease Control (CDC) and joins 15 other states and 2 cities across the United States that are also conducting climate adaptation planning efforts from a public health perspective through the CDC Climate Ready States and Cities Initiative.
- Partner with the Bay Area's Climate Readiness Institute to stay up to date on climate-related health issues and related planning, and to bring health messages into the mainstream of climate change communications and extreme heat event response strategies
- CDC's Assessing Health Vulnerability to Climate Change: A Guide for Health Departments

- CA Climate Change Portal: Public Health and Climate Change Adaptation

- The CEC publication *Mapping Climate Change Exposures, Vulnerabilities, and Adaptation To Public Health Risks In The San Francisco Bay and Fresno Regions* provides an overall assessment of climate change adaptive capacity of the San Francisco Bay Area. Maps in the report demonstrate that different parts of the region have higher vulnerability for different components of vulnerability. Consistent with Palo Alto's CalEnviroScreen scores, the most vulnerable areas for air pollution exposures are on the most heavily trafficked highway corridors surrounding the most populated areas of the San Francisco Bay Area, such as Highway101 along the Peninsula connecting San Jose and San Francisco.

Buildings and Property (BP)

Coastal flooding associated with sea level rise represents the biggest climate-related risk to buildings and property. The long-term protection of property and infrastructure located in the Palo Alto coastal floodplain (including parks and open space) is currently dependent on existing levees, which are too low to provide FEMA-certified flood protection and do not meet current state and federal engineering standards. The SAFER Bay project is currently addressing this risk.

Buildings and property located in certain areas of the foothills are in high risk zones for wildfires by the year 2100. The vulnerability of these assets should be better defined, along with outreach to property owners about the risks and best management practices for fire protection.

The following general response actions are recommended to minimize climate risk to buildings and property:

- Engage the public and promote community awareness and involvement in actions to reduce climate change risks, using linguistically and culturally appropriate approaches that are effective for diverse populations.

- Engage with and seek support from ABAG's community resilience programs; in particular their multiple hazard risk assessment and study of housing resilience in the face of natural disasters.

Solid Waste / Hazardous Material (SM)

No assets in this category are deemed to have significant risk from climate change exposures by the year 2100. However, the existing Palo Alto landfill and its infrastructure for landfill gas capture and groundwater pumping are potentially at risk from sea level rise. These risks should be assessed and landfill's current protections should be evaluated for resiliency and potential improvements to protect against sea level rise.

Natural Areas, Ecosystems (NE)

With respect to the City's natural areas and ecosystems, tidal marshes and coastal wetlands are the most vulnerable from climate change by 2100, facing significant risk from sea level rise which is expected to alter habitats primarily through increasing inundation. The storm-buffering and water quality services provided by marshes and wetlands will also be diminished. Sea level rise is being

considered in the current Technical Update to the Bayland Ecosystem Habitat Goals[60] Technical Update and City of Palo Alto's Baylands Master Plan. The City should also integrate ecosystem considerations with the SAFER Bay project and assess the potential for marsh-to-uplands ecotones to improve adaptability of tidal marshes to sea level rise. Such projects also offer the potential co-benefits of using natural marsh habitats to provide advanced wastewater treatment.[61]

Public Works has recently updated the approved street tree list in anticipation of climate change impacts including longer periods of drought and more limited water supplies for irrigation. Coast redwoods are no longer approved, and the City is in the process of identifying more drought-tolerant species that are appropriate for Palo Alto and can tolerate higher salinity water, to allow more use of recycled water for irrigation needed in early growth stages.

Establishing a Shoreline Vision

The adaptation actions described above need to be woven into a larger vision of the Palo Alto shoreline that addresses not only climate change but also pre-existing and perhaps more immediate issues such as water quality, the protection of the Baylands ecology, public access and recreation. Much of the shoreline infrastructure, including levees, flood control facilities and waste water treatment plants that are more than 50 years old, were built in the Clean Water Act era when federal and state grants covered most costs. Even though concerns about maintaining our infrastructure have been growing for decades, a commensurate increase in funding has not occurred. Beyond the price tag, the regulatory and institutional challenges of doing multi-benefit projects remain substantial. When clean water regulations, flood control specifications, and Bayfill policies were written 20-50 years ago, conditions were quite different than they are today or what they are projected to be in the future. More recently, scientific results from regional water quality monitoring programs and ecosystem restoration activities are suggesting the need to adjust priorities for the management of wastewater, sediment and flooding while continuing to protect the Bay's ecological resources.

There are lessons to be learned from international experience, such as the approaches used by the Dutch. However we should also bear in mind the ecological, political and cultural landscape of the Bay is quite different from other places as is the attitude to risk. This can be observed in how different countries and states approach flood risk management and shoreline management. Replication of strategies isn't as effective as understanding the philosophy and making a local interpretation. For instance the "Making Room for Rivers" concept from the mid 1990's in the Netherlands is very similar to the "Living Rivers" concept from the U.S. during the same period and traces its origins to the Yolo bypass a century before. In the U.S., with a less centralized government and a more varied natural environmental setting, we are likely to see much more variation in adaptation response than in the Netherlands.

Retreat in urban areas is inherently difficult. There are not many examples along the Bay shore beyond Hamilton Airfield (which converted an airfield into a wetland) and Inner Harbor Redwood City (which plans to accommodate sea level rise with a park like buffer). In general, shoreline restorations have left the most contaminated sites (e.g., closed landfills) in place. Retreat presents huge societal

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[60] Baylands Ecosystem Habitat Goals, 1999. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif.

[61] See description of Oro Loma Ecotone Demonstration Project: http://bairwmp.org/projects/building-climate-resiliency-along-the-bay-through-green-infrastructure/

and political challenges that will generate decades-long debates. It could be said that current adaptation strategies, which largely focus on maintaining the existing levee alignment, are buying us time for much harder decisions to be made.

Location is important. The appropriate adaptation strategy depends upon the geomorphology, the ecology, the assets at risk, the appetite for risk, the resources available, and current legislation. It could be argued that the combination of FEMA, the Clean Water Act and the Endangered Species Act have a big impact on the U.S. landscape and will do so in the future. Regulation needs to evolve along with adaptation strategies, continuing to protect the environment and natural habitats but allowing room for innovation and response actions as the environment changes over the next century and beyond.

The City should engage stakeholders in a discussion on shoreline resiliency that considers multiple objectives, which could lead to more effective capital improvement plans, better access to different financial and material resources, and approaches that provide co-benefits to issues beyond climate change.

APPENDIX G – Additional Technical Analysis

Transportation emissions attributable to Palo Alto residents

A significant portion of vehicle emissions result from non-residents commuting into the City for work. As **Figure 8** shows, the number of jobs in the City is significantly higher than the number of employed residents. While the exact number of employed residents is not known, we have estimated that 75% of total jobs in Palo Alto are filled by non-residents, and 25% by residents, and have allocated the vehicle-related GHGs proportionately.[62]

Figure 8: Estimated Palo Alto Jobs Filled by Residents vs. Non-Residents

Category	Number of People	Percentage of Total Jobs in Palo Alto
City Population	66,955[63]	N/A
Jobs in Palo Alto	89,370[64]	100%
Employed Persons Residing in Palo Alto	31,007[65]	N/A
Employed Persons Residing + Working in Palo Alto	22,976[66]	25.7%
Jobs in Palo Alto Filled by Non-Palo Alto Residents	66,394	74.3%

Water Heating in Businesses

Finding an electric solution to domestic hot water heating in any application is easy, but not all electrification strategies are created equal. The list below outlines strategies to move away from gas for domestic hot water. While each solution might be the right choice depending on the building design, we've outlined these in general from most to least efficient:

1. **Stop Using Hot Water**: Palo Alto is not going to start making people take cold showers, but minimizing hot water use will decrease the cost to the community of transitioning away from

[62] An estimated 25.9% of employed Palo Alto residents have a travel time to work of at least 30 minutes[62]. If we assume that all of these employed residents with a commute of at least 30 minutes work outside of Palo Alto, it would indicate that approximately 22,976 residents work in Palo Alto – accounting for 25.7% of the total jobs in the City. The remaining estimated 74.3% of total jobs in Palo Alto – 66,394 jobs would be filled by non-residents.
[63] http://quickfacts.census.gov/qfd/states/06/0655282.html
[64] http://files.mtc.ca.gov.s3.amazonaws.com/pdf/Plan_Bay_Area_FINAL/pbafinal/index.html
[65] http://www.cityofpaloalto.org/civicax/filebank/documents/37935
[66] http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF : Assumes all residents employed in Palo Alto with a commute to work of at least 30 minutes work outside the City limits

natural gas. Bathrooms sinks in office building and retail stores do not need hot water; suddenly a piping system supplying an entire high-rise can be replaced by heaters located only at showers and kitchens. In addition, low flow fixtures on domestic hot water systems, such as low flow showerheads can provide immediate payback on the energy-side.

2. **Free Waste Heat:** Using free waste heat from air conditioning systems can be extremely effective. This is most easily applicable on large buildings with simultaneous air conditioning and domestic hot water demand. Think large hotels or commercial high-rises with attached restaurants.
3. **Solar Hot Water**: Hotels and hospitals are ideal candidates for solar hot water systems as they have notoriously high hot water demand for showers and washing of clothes and linens. Solar hot water systems are four times as efficient at collecting the sun's energy as solar photovoltaic systems. However, all solar hot water systems need backup energy, and to move off of natural gas, that back up…
4. **Heat Pump Hot Water:** Heat pumps are a 60-year old HVAC technology, but have only recently been used for domestic hot water heating in the United States. They are 250% more efficient than electric resistance systems and provide gas-free hot water at a positive net present value.
5. **Electric Resistance**: Electric resistance hot water heating is available in both tank-type, and tank-less instantaneous configurations. We use it regularly in coffee machines and dishwashers. While it is the least efficient option available, it is simple and inexpensive to install, and might be the best option in small facilities with low demand.

Hot water use in Palo Alto's commercial building stock can be looked at through two major differentiators (see Figure 9). Commercial buildings that fall under the "small" and "low hot water demand" categories outline below make up the vast majority of Palo Alto's commercial building stock and account for an estimated 80% of Palo Alto's natural gas consumption associated with commercial hot water use[67]. Fortunately, these types of commercial hot water systems present the lowest cost, immediate opportunities for electrification of water heating equipment. Concurrent to focusing on near-term retrofits of buildings meeting these criteria, Palo Alto will also focus on education and outreach, and demonstration projects for larger, more complex water heating systems.

Figure 9: Approaches for Addressing Hot Water Use in Commercial Buildings

Small vs. Large Buildings	
Small buildings, 25,000 sqft or smaller, tend to have all hot water fixtures grouped into one or two primary areas. The collocation of fixtures and lack of dedicated piping, make these buildings simple to design and inexpensive from a capital	**Large** commercial buildings can often have complicated domestic hot water piping systems with hot water fixtures in different areas throughout a building. The volume of water in the pipes alone reaches 1,000s of gallons. While some buildings, like offices, don't use much hot water,

[67] DNV GL analysis based on gas consumption data form CPAU, the California Commercial End Use Survey,

cost standpoint.	electrifying the system can be more complex and project specific
Low vs. High Hot Water Demand	
Building types with **low hot water demand** include offices, schools, and retail stores. Few, if any, showers are taken and in many cases the buildings entire hot water demand could be replaced with an electric resistance hot water showerhead or kitchen fixture. The low annual energy use associated with domestic hot water means that even a technology as inefficient as electric resistance can be implemented without high annual energy cost implications, so long as it is done intelligently, with the hot water heating system located near hot water fixtures.	As mentioned above, hotels, hospitals, and restaurants typically have **high hot water demand**. At these levels, solar hot water systems start to make sense and innovative solutions become a necessity to keep annual costs down. Systems should be carefully designed when switching these facility types away from gas hot water heating.

Space Heating in Businesses

Palo Alto's high-rise office buildings, hotels, hospitals, and laboratories tend to utilize more complex systems due to occupancy type and overall building design. Central boiler and chilled water systems tend to enable more efficient HVAC operation, but can be difficult to switch over to all-electric systems. A variety of options exist, some of which can run off the existing heating hot water system infrastructure, and some that require a drastic HVAC re-design. Properly timing the changeover to take advantage of incremental costs savings can be beneficial. T HVAC re-redesign should be considered when equipment reaches the end of its useful life, or when a building is getting a major architectural renovation (a good way to tell if a renovation is 'major' is whether ceilings are being replaced.)

The table below outlines the appropriate electrically-heated replacement equipment based on existing commercial building heating infrastructure.

Existing Equipment	Becomes
Gas-fired rooftop packaged units	Rooftop packaged heat pumps
Gas-fired central boiler systems	Solar, Heat recovery chillers, Heat pump hot water, water-source heat pumps, or electric resistance central boiler systems
Gas-fired radiant heating systems	Electric radiant heating systems

Space Heating in Homes

Currently, heating in Palo Alto is typically accomplished using one of four systems:

1. **Central heat pumps, ducted throughout the residence**

These systems are already electrically heated. They serve as proof that it is possible and practical to heat with electricity in Palo Alto. With energy factors in the 240% range, they are likely to be the standard heating system in years to come.

2. **Central furnaces with air conditioning, ducted throughout the residence**

Air-conditioned homes are prime candidates to change to a heat pump system when the furnace or air conditioner fails. Because they already have air conditioning, all the main components of a split system heat pump, including space for the exterior condensing unit are there. A heat pump is only marginally more expensive than an equivalent air conditioner, due to its ability to run in reverse.

3. **Central furnaces without air conditioning, ducted throughout the residence**

Homes with a furnace, but no air conditioning pose the biggest challenge. The lack of an air conditioner means the capital cost and exterior space typically reserved for the residential air conditioner cannot be leveraged for a heat pump. There are a variety of options for switching to electric heating, each with their own pros and cons:

Retrofit System Options	Pros	Cons
Central Heat Pump	Utilizes existing ductwork High efficiency Option to add A/C	High capital cost Exterior space requirement
Central Electric Furnace	Utilizes Existing ductwork Low capital cost	Inefficient
Ductless Mini-splits	High efficiency Option to add A/C Zoned	High capital cost Exterior space requirement Does not utilize existing ducts
Radiant Underfloor Electric	Heats people instead of air High comfort level Zoned	Must integrate with floor Capital cost

Radiant Baseboard	Heats people instead of air High comfort level Zoned	Must integrate with furniture Capital Cost Aesthetics

4. **The Eichler Home: Radiant floor, with hot water piped throughout the residence.**

"We love our radiant heating system," is a common quote from Eichler home residents. The midcentury modern design by Joseph Eichler is a staple in Palo Alto and almost always includes a hydronic radiant floor system. The system is characterized by gas-fired hot water tanks which provide hot water to piping found underfloor throughout the residence.

If maintaining the current underfloor heating system is preferred, this can be done by replacing the current gas boiler with an electric boiler, or heat pump hot water heater. The heat pump hot water heater is a less common approach, but will yield high efficiency gains, while an electric boiler will result in increased energy costs compared to natural gas.[68]

If maintaining the underfloor system is not preferred, the options for going electric are the same as the options listed for a furnace system above.

All-electric Zero Net Energy Buildings

An all-electric, zero net energy new home are not be that different in cost or appearance than a typical new home. In order to minimize the cost of the solar PV system, it is important to consider passive design strategies to reduce overall energy requirements, including strategies such as:

- **Orientation and Massing**: The home should be oriented to minimize solar heat gain from east and west facades, and maximize natural airflow through the building. These strategies will also provide the "cool breeze" and "natural daylight," two features which increase resale value. Roof design should be simple on the South side to allow for easy and aesthetically pleasing placement of solar panels.
- **Shading:** Deciduous trees and overhangs on Southern facades provide shading which will drastically reduce air conditioning cost, and the associated solar required to offset that energy.
- **Envelope:** Proper insulation and window selection will ensure heating and air conditioning costs do not have a major impact on energy bills.

In addition to reducing energy requirements, zero net energy, all-electric homes in Palo Alto will need to rely on the following electric technologies that are commonly available today:

- Heat pump hot water systems

[68] Reference Aimee Baily analysis here…and perhaps quote from it

- Heat pump or radiant electric heating systems
- Induction ranges and electric ovens
- LED lighting
- Rooftop solar photovoltaics to generate on-site renewable energy

Meeting Date: 04/18/2016

Earth Day Report 2016 (EDR16)

From: City Manager

This is an informational report and requires no Council action.

Executive Summary

During the past year, Palo Alto has continued to advance its sustainability commitments, including evaluation of electrification options; drought response; managing dewatering issues; launching a downtown transportation management association and convening a regional dialog on mobility alternatives; and development of a new Sustainability and Climate Action Plan (S/CAP) to provide strategic focus to existing and new sustainability initiatives.

Background

Palo Alto created its first sustainability plan in 2002, and its first Climate Protection Plan in 2007. In the intervening years it has undertaken hundreds of sustainability initiatives, which are summarized annually in an "earth day report" (EDR). This year, because of staff focus on development of the S/CAP, the EDR is condensed, including this summary staff report and appendices that provide more substantial quantitative and qualitative detail.

Discussion

Sustainability and Climate Action Plan (S/CAP)
The Sustainability and Climate Action Plan (S/CAP), being brought to Council tonight, is an effort to (1) update Palo Alto's climate goals, strategies and actions; (2) use the S/CAP as a vehicle integrate Palo Alto's hundreds of sustainability-related initiatives; and (3) approach these issues in ways than improve quality of live, build prosperity and enhance the community's resilience—its ability to respond effectively to stress and crisis.

Resource use
Note that while some reported data (e.g., electricity, natural gas and water use) is measured, other reported data (e.g., emissions from transportation and solid waste) are estimates and should be considered approximate; variations smaller than +/-10% may not be meaningful.

GHG Emissions: City and community greenhouse gas (GHG) emissions declined in 2015 to an estimated 36% below 1990 levels, compared to 35% in 2014 (effectively no change, given the precision of the underlying data. Updated calculation methods for transportation and solid waste related emissions make comparison with estimates reported in prior years difficult, but the trends are directionally the same.

GHG Emissions from City Operations: City natural gas emissions for 2015 dropped 37% since 2014, largely as a result of the City signing on to the PaloAltoGreen Gas program in July of 2015. City solid waste related emissions have declined modestly; updated calculation methods have shifted both current estimates and baseline year estimates.

GHG Emissions from City and Community Activities: City and community transportation related emissions in 2015 declined an estimated 1% since 1990, and 11.5% since 2005, but have increased an estimated 3% since 2013, possibly due to revised calculation methodologies. (Transportation represents the largest component of Palo Alto emissions; estimates are both the least stable as methodologies change and the least accurately estimated; staff will bring Council a proposal to minimize that problem.) Community-wide natural gas emissions for 2015 dropped 3% since 2014, as a result of both ongoing efficiency measures and about 2% of customers enrolling in CPAU's opt-in PaloAltoGreen Gas program.

Water Consumption: Per capita water consumption has dropped nearly 33% since 2005, with about one-third of that drop in the last year, largely as a result of the community's exceptional response to the current "drought."

Highlights and Accomplishments from City Departments (See Attachment D)

Administrative Services Department (ASD): Drafted three year Green purchasing plan, continued to iteratively green prioritized goods, services and purchasing operations, Implemented eProcurement, collaborated on Urban Sustainability Director Network green purchasing partnership

City of Palo Alto Utilities (CPAU): Achieved RPS of 26.0% in 2015, on track to 57.5% in 2017. Due to drought conditions, hydroelectric power declined to less than 30% of CPAU's portfolio in 2015, which necessitated purchase of additional RECs to compensate for additional market power purchases. Grew local solar programs. Natural gas use declined 15%, largely due to warm weather and water conservation. Launched the PaloAltoGreen Gas program, with 2% participation by the end of 2015. Developed pilot heat pump water heater (HPWH) program. CPAU is leading Palo Alto's participation in the Georgetown University Energy Prize, competing against 49 other cities for a $5m prize..

Community Services Department (CSD): Reduced the potable water use in our parks and open space areas by 35% (based on 2013 base year). In partnership with Save the Bay and volunteers, removed over 20,000 pounds of invasive weeds from the Baylands and planted 8,000 native plants. In partnership with Canopy, planted 135 native trees throughout the City of Palo Alto's parks.

Development Services: Developed and adopted New Green Building Ordinance and Energy Reach Code. Continuing to streamline EV and other permitting processes. Studying electrification feasibility and potential PV default requirements for new construction.

Library: Participated in Silicon Valley Reads 2016 (siliconvalleyreads.org): “Chance of Rain: The Impact of Climate Change in our Lives.” Open Mitchell Park LEED Platinum library, and won multiple other design awards.

Planning and Community Environment (PCE): Comprehensive Plan update; launch and support Transportation Management Association (TMA); develop plans for expanded shuttle service; implemented residential parking permits, developed paid parking and transportation impact fee studies.

Office of Emergency Services (OES): Evaluating renewable back up power and microgrids for Cubberly and other critical sites. Integrating climate and other risks into community engagement public safety education and Community Risk Reduction and Emergency Preparedness

Office of Sustainability (OOS): Developed S/CAP; developed Sustainability Dashboard; joined global Compact of Mayors; convened City and regional explorations of “mobility as a service” (MaaS); worked with other departments on electrification, procurement and other initiative. Raised $350k in funding for EV chargers and a multi-city collaboration exploring how to more effectively fund municipal sustainability initiatives

Public Works Department (PWD): Benchmarking City buildings energy and water use and cost. Implementation of Title 24 Building Energy Efficiency Standards. Began drafting a Citywide facilities energy management plan. Implemented “EV First” policy for City fleet; installed additional EV chargers at City facilities. Advanced Regional Water Quality Control Plant (RWQCP) recycled water program. RWQCP GHGs rose slightly in 2015.

Attachments

Attachment A: Summary of 2007 Climate Protection Plan
Attachment B: City Municipal Operations Emissions
Attachment C: Palo Alto Community and City Municipal Operations GHG Emission
Attachment D: Highlights of Sustainability Initiatives by City Municipal Operations

Attachment A: Summary Description of the 2007 Climate Protection Plan

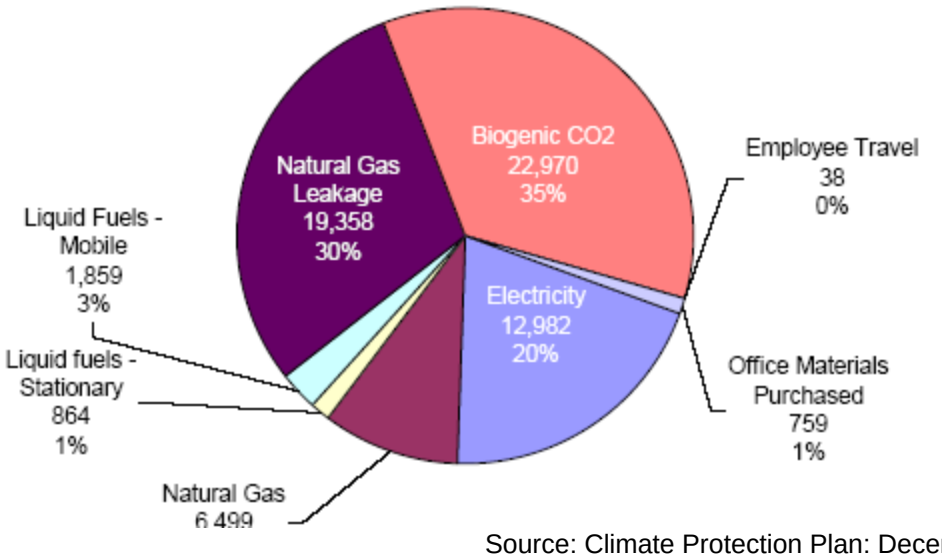
NOTE: Emissions estimate have been updated since 2007, and is reflected in the body of the report. This summary is for reference purposes only.

In December 2007 Council approved a Climate Protection Plan (CPP) that set a short, medium, and long term goals to reduce City operations and community greenhouse gas (GHG) emissions. These goals were:

1. Short Term Goal: By 2009, the City Operations will reduce emissions by 5% from 2005 emission levels for a total reduction of 3,266 metric tons of CO_2.
2. Medium Term Goal: By 2012 the City Operations and Community will reduce emissions by 5% from 2005 emissions level for a total reduction of 29,702 metric tons of CO_2.
3. Long Term Goals: By 2020, the City Operations and Community will reduce emissions by 15% of 2005 levels, equal to 119,140 metric tons of CO_2, and bring the community in line with State emission reduction goals.

Outlined below in Figure 1 and Figure 2 are the City's and Community's GHG emissions profiles, as outlined in the 2007 CPP. The City's emissions of 65,329 Metric Tons of CO_2e (MT CO_2e) and the community's emissions of 728,720 MT CO_2e combined is equivalent to approximately 14 tons per resident. Electricity and natural gas related emissions account for approximately 40% of the 793,621 MT CO_2e total municipal plus community emissions. (Note: the natural gas leakage estimate has since been substantially revised downwards, from 19,358 MT CO_2e to 4,717 MTCO_2e.)

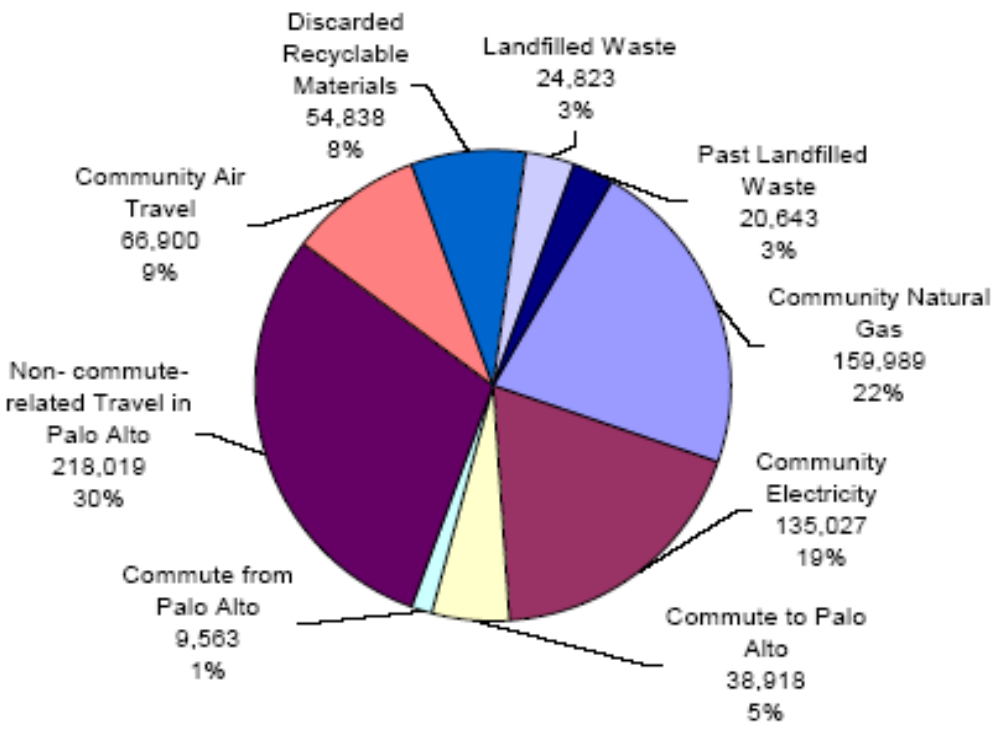
Figure 1: Municipal (City Operations) GHG Emission Sources in 2005 (65,329 MT CO_2e)



Source: Climate Protection Plan: December 2007

Note: Natural gas leakage numbers were updated with more accurate numbers since 2007 that resulted in considerable reduction in leakage estimates.

Figure 2: Community GHG Emission Sources in 2005 (726,720 MT CO_2e)



Source: Climate Protection Plan: December 2007

B. Short Term GHG Reduction Goals

The City operations undertook a number of departmental level initiatives to meet the goal to reduce municipal GHG emissions by 5% at the end of 2009. Utilities energy efficiency and conservation programs were integral part of this effort. The initiative was classified under five main categories: employee education, electricity conservation and efficiency upgrades, paper use reduction, commute reduction, and waste reduction. A revised 2005 benchmark of 29,364 MT CO_2e was established. This lower benchmark down from 65, 329 MT, figure 1 above) reflects the reduced estimate for natural gas leakage and biogenic emissions from the waste water treatment plant because the facility serves other cities too and Palo Alto has minimal control over those emissions.

April 2010 Update

In April 2010, staff reported to Council that municipal GHG emissions declined by 11% in 2009 relative to the revised baseline year of 2005 (excluding employee commute estimates) (CMR: 194:10). Emissions were down from 29,364 MT CO_2e to 25,518 MT CO_2e. The principle contributors to this reduction are outlined below:

- Major upgrades and process improvements at the water quality plant, accounted for 75% of the reduction
    - Replace natural gas used in the biosolids incinerator emission control equipment with landfill gas that had previously been burned in a flare
    - Improve aeration system and replace air diffusers
    - Install more efficient motors and lighting fixtures

- Upgrade building systems and fixtures
    - Lighting fixture upgrades at the Elwell Court building
    - Reduced lighting levels at selected locations
    - City hall upgrades: motors, boilers, HVAC system

Updated 2012 GHG Reduction Goal for the City

Based on the progress made since 2007, City Council in 2010 increased the City municipal GHG reduction goal to 20% below 2005 levels by 2012.

Attachment B: GHG Emissions of City Municipal Operations: Comparison Data

City municipal operations related emissions drivers and associated emissions are shown below.

Table B1: City Operations GHG Emission in 2005 and 2012-2015 (in MT of CO_2 equivalent)

– Biogenic and Anthropogenic, no adjustment for hydro conditions or PAG purchases –

	2005			2012			2013			2014			2015		
	Scope 1	**Biogenic**	**Scope 2**	**Scope 1**	**Biogenic**	**Scope 2**	**Scope 1**	**Biogenic**	**Scope 2**	**Scope 1**	**Biogenic**	**Scope 2**	**Scope 1**	**Biogenic**	**Scope 2**
Buildings and Other Facilities	8,723	0	1,819	7,016	0	1,155	5,365	0	0	8,177	0	0	8,053	0	0
Streetlights and Traffic Signals	0	0	689	0	0	534	0	0	0	0	0	0	0	0	0
Water Delivery Facilities	2	0	67	34	0	42	91	0	0	41	0	0	54	0	0
Wastewater Facilities	8,504	16,689	2,546	6,414	15,602	1,950	5,024	11,183	0	4,913	10,861	0	5,840	11,054	0
Vehicle Fleet	2,835	1	0	2,546	0	0	2,399	0	0	2,523	0	0	2,373	0	0
Power Generation Facilities	0	0	8,570	227	0	3,839	0	0	0	23	0	0	333	0	0
Solid Waste Facilities	6,846	2,994	29	4,336	3,765	19	6,642	2,919	0	8,470	6,436	0	8,014	5,941	0
Other Processes & Fugitive Emissions	3	0	0	9	0	0	4	0	0	4	0	0	6	0	0
	26,912	**19,684**	**13,720**	**20,582**	**19,367**	**7,539**	**19,525**	**14,102**	**0**	**24,151**	**17,297**	**0**	**24,673**	**16,995**	**0**

Scope 1 and Scope 2 emissions are non-biogenic emissions that are caused by human activity. Biogenic emissions are assumed to be net carbon neutral and not reported under GHG emission reporting protocols. Scope 2 emissions from electricity were eliminated starting in 2013 by the purchase of Renewable Energy Credits (RECs) under the Carbon Neutral Plan. Table B2 below shows the transformation of the data in Table B1 above by excluding biogenic emissions, and shows a 39.3% reduction in Scope 1 and Scope 2 emissions from the 2005 baseline.

Table B2: City Operations GHG Emission in 2005 and 2012-2015 (in MT of CO_2 equivalent)

Excludes Biogenic, not normalized for hydro conditions or PAG purchases

GHG Emissions comparison (Scope 1 & 2)	*2005*	*2012*	*2013*	*2014*	*2015*
Water Delivery Facilities	69	76	91	41	54
Wastewater Facilities	11,049	8,364	5,024	4,913	5,840
Vehicle Fleet	2,835	2,546	2,399	2,523	2,373
Streetlights & Traffic Signals	689	534	0	0	0
Solid Waste Facilities	6,876	4,354	6,642	8,470	8,014
Power Generation Facilities	8,570	4,067	0	23	333
Buildings & Other Facilities	10,542	8,172	5,365	8,177	8,053
TOTAL	40,629	28,112	19,521	24,147	24,667
Percentage reduction from 2005 baseline		30.8%	52.0%	40.6%	39.3%

Table B2 does not include the effects of the purchase of PaloAltoGreen resources and the normalization of the vagaries of hydroelectric supply conditions. Table B3 below *does* adjust for these two effects and shows a 47.6% reduction in emissions from the 2005 baseline year.

Table B3: City Operations GHG Emission in 2005 and 2012-2015 (in MT of CO_2 equivalent)

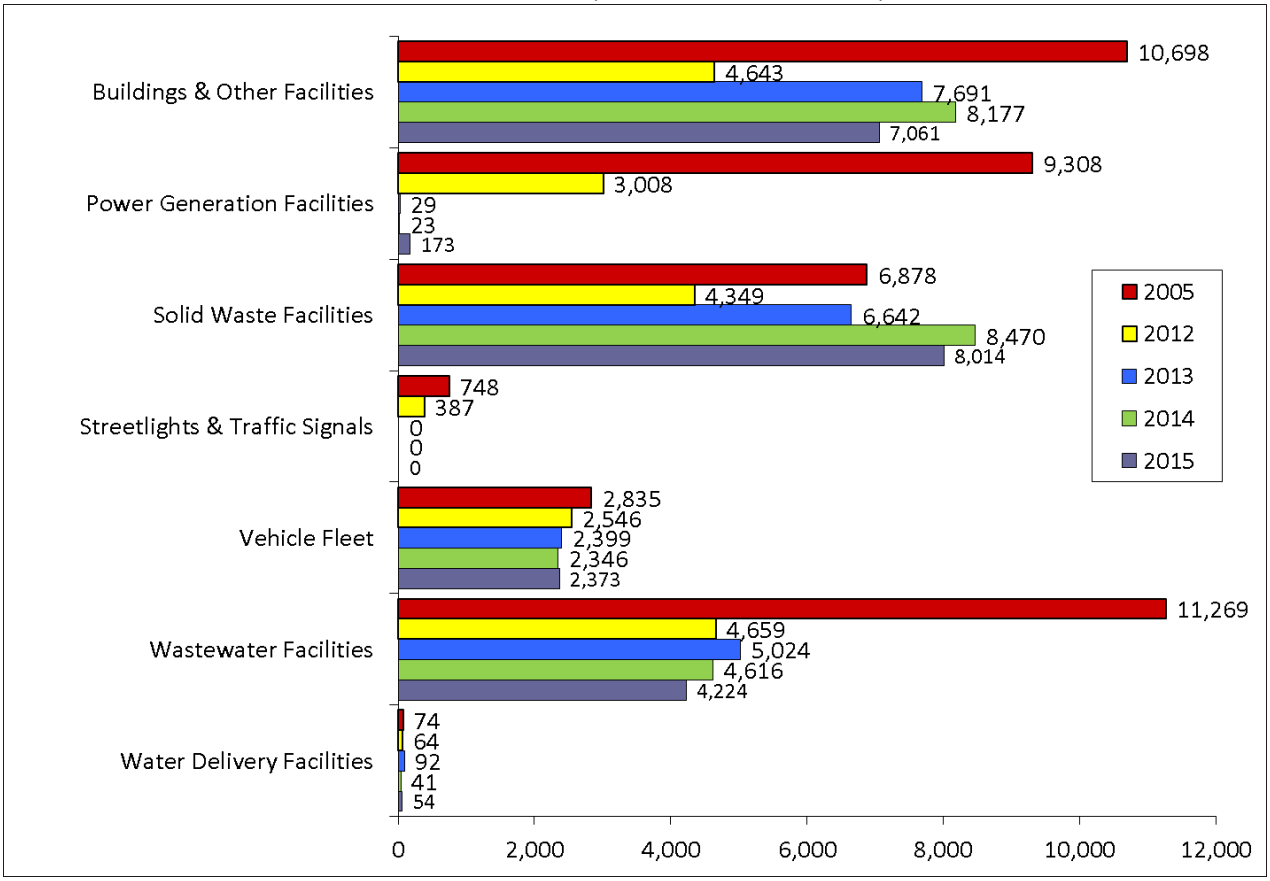
Excludes Biogenic, normalized for hydro conditions and PAG purchases

GHG Emissions comparison (Scope 1 & 2)	*2005*	*2012*	*2013*	*2014*	*2015*
Water Delivery Facilities	74	64	91	41	54
Wastewater Facilities	11,269	4,659	5,024	4,616	4,225
Vehicle Fleet	2,835	2,546	2,399	2,346	2,373
Streetlights & Traffic Signals	748	387	0	0	0
Solid Waste Facilities	6,878	4,349	6,642	8,470	8,014
Power Generation Facilities	9,308	3,008	0	23	173
Buildings & Other Facilities	10,698	4,643	5,365	8,175	7,060
TOTAL	41,811	19,655	19,521	23,670	21,899
Percentage reduction from 2005 baseline		53.0%	53.3%	43.4%	47.6%

Figure 1 below graphically illustrates Table B3 and is a reproduction of Figure 1 from the body of the report.

Figure 1: City Operations GHG Emissions: 2005 and 2012-2015 (Hydro and PAG-adjusted)

Total Emissions Reduced from 42,000 MT in 2005 to 21,900 MT in 2015



The primary drivers for GHG emission reduction performance are:

- Building and Other Facilities – Due to enactment of the Carbon Neutral Plan in March 2013, all electricity consumed by the City in 2013 had zero carbon emissions. The City began purchasing carbon offsets through the PaloAltoGreen Gas (PAGG) program in July 2015, which reduced emissions from natural gas consumption relative to 2014.
- Power Generation Facilities – This category accounts for transmission and distribution system losses. The City divested its ownership of the COTP transmission line in 2009, resulting in a lower loss allocation to the City. Distribution loss-related emissions also were eliminated in 2013 due to carbon neutral electric supplies.
- Solid Waste Facilities – Closure and capping of the landfill, resulting in less methane production and leakage in CY 2012. Higher collection and improved monitoring, combustion of biogenic landfill gas through flaring, and uncaptured methane leakage have resulted in increased emissions since 2014.

- Streetlights and Traffic Signals – No emissions are reported due to conversions to highly efficient LED streetlights (note, only metered fixtures are shown) and carbon neutral electricity supply.
- Vehicle Fleet – Fleet Services saw a slight reduction in consumption of CNG fuels in 2014 and 2015.
- Wastewater Facilities – 63% emissions reduction from 2005 baseline reflects use of landfill gas for incinerator, optimized use of gas from incinerator tuning, and use of carbon neutral electricity. The 16% decrease from 2013 was due to decreases in the volume of nitrogen effluent discharge.
- Water Delivery Facilities – There has been fluctuating energy use for water pumping, with a decrease in activity for 2014 and 2015.

Palo Alto Community & City Municipal Operations GHG Emission:
Restated reduction of 33% since 2005, 36% since 1990

	1990		2005		2012		2013		2014		2015		
	Consumption Quantity	**Emissions (MT CO2e)**	**Consumption Quantity**	**Emissions (MT CO2e)**	**Consumption Quantity**	**Emissions (MT CO2e)**	**Consumption Quantity**	**Emissions (MT CO2e)**	**Consumption Quantity**	**Emissions (MT CO2e)**	**Consumption Quantity**	**Emissions (MT CO2e)**	Notes
Scope 1 Emissions													
Natural Gas Use (therms)	36,589,986	194,000	31,374,970	166,350	30,086,536	159,519	30,336,076	160,842	26,103,713	138,402	*25,491,698*	*135,153*	1
Natural Gas Distribution Leakage		4,718		4,718		4,718		4,718		4,781		*4,781*	2
Palo Alto Landfill Fugitive Emissions		24,325		9,900		6,451		5,110		9,427		*8,617*	3
Palo Alto Landfill Gas Flaring (biogenic)		11,993		2,994		3,765		2,919		6,436		*5,941*	3
Wastewater Process Emissions		8,504		8,504		6,414		5,024		4,616		*4,080*	*4*
Scope 2 Emissions -- Actual													
Total Electric Load (MWh)			996,091		966,839		986,241		978,561		*965,857*		
Hydro Supply (MWh)			548,760		413,584		406,570		266,026		*251,466*		
Renewables Supply (MWh)			49,980		188,566		188,086		172,139		*227,110*		
Brown Power Supply (MWh)		186,000	397,352	158,427	364,689	145,404	391,585	0	540,370	0	*487,280*	*0*	*5a*
Palo Alto Green Purchases (MWh)			30,601	-12,201	75,805	-30,224		N/A		N/A		*N/A*	*6*
Scope 2 Emissions -- Weather Adjusted* **													
Total Electric Load			996,091		966,839		986,241		978,561		*965,857*		
Hydro Supply (MWh)			514,073		514,073		514,073		514,073		*514,073*		
Renewables Supply (MWh)			49,980		188,566		188,086		172,139		*227,110*		
Brown Power Supply (MWh)		186,000	432,038	172,257	264,200	105,339	284,082	113,266	292,324	116,552	*224,673*	*89,579*	*5b*
Palo Alto Green Purchases (MWh)			30,601	-12,201	75,805	-30,224	0	0	0	0		*0*	*6*
Scope 3 Emissions													
Commute into, from, and within City		331,840		371,870		319,720		319,720		329,296		*329,296*	*7*
Lifecycle Emissions From Annual Waste Placed in Landfills		7,953	22,265	7,953	14,082	5,030	14,549	5,197	15,087	5,389	*14,012*	*5,005*	*8*
Landfilling Recyclable Material		22,779		22,779		14,406		14,886		15,435		*14,335*	*8*
Total Emissions (weather adjusted, biogenic excluded)		**780,119**		**752,130**		**591,373**		**515,497**		**507,346**		*501,267*	
					Emission Reduction (since 2005)	**21%**	**Emission Reduction (since 2005)**	**31%**	**Emission Reduction (since 2005)**	**33%**	**Emission Reduction (since 2005)**	***33%***	
					Emission Reduction (since 1990)	**24%**	**Emission Reduction (since 1990)**	**34%**	**Emission Reduction (since 1990)**	**35%**	**Emission Reduction (since 1990)**	***36%***	

Notes

1	*Total Community supply of natural gas use/delivery. Adjusted for purchases of carbon offsets through PaloAltoGreen Gas program.*
2	*Leakage from the natural gas distribution system- modeled result, unchanged over the period.*
3	*Now using 40CFR Part HH methodology, per AB32. Estimates provided in prior estimates have been revised to reflect current methodology.*
4	*Represents N2O emissions from biological treatment process and release of Nitrogen.*
5	*a. Represents actual quantity of brown power related emission @ 879 lbs/MWh in 2005 and 2012; not applicable beyond 2012 due to Carbon Neutral electric supply.* *b. Weather normalized (for hydroelectric generation) quantity of brown power. No GHG impact in 2015.*
6	*Emissions saved due to purchase of PaloAltoGreen related RECs. PAG related RECs not included in 2015 due to Carbon Neutral electric supply.*
7	*Study results from Fehr and Peer (03/19/2013) using Valley Transportation Authority regional transportation model based Vehicular Miles Travelled (VMT) and vehicular profiles - does not account for Palo Alto specific parameters related to greater penetration of alternate fuel vehicles, bicycle use, etc. Study results under review. 2015 assumed to be same as 2014.*
8	*Based most recent EPA WARM methodology, based on characteristics and tons of material landfilled; prior reports relied on 2005 methodology. Landfilled amount in 2014 up 4% compared to 2012.*
*****	*Municipal emissions related to electricity and natural gas consumption included within utility load numbers; fleet vehicle emissions also assumed to be included in community wide commute related emissions estimates made by consultant.*
******	*Table excludes biogenic emissions related to: Landfill gas flaring and WQCP sludge incineration.*
*******	*Normalized to account for the vagaries of weather on hydroelectric supplies. No GHG impact starting in 2013 due to Carbon Neutral Plan.*
********	*1990 emissions data, where unavailable, were assumed to be equal to 2005 values.*

Attachment D: Highlights of Sustainability Initiatives by City Municipal Operations

Department Name: Administrative Services Department (ASD)

Background: ASD provides financial, analytical, budget, strategic and administrative support services for City departments. The Purchasing Division has lead responsibility for implementing city policies to incorporate sustainability considerations into the City's purchasing processes.

Strategy: The Purchasing Division works closely with the City's interdepartmental Green Purchasing Team to bring sustainably sourced, produced and delivered products and services to all municipal departments, and to provide track and evaluate the success and impacts of these programs.

Goals: To increase the City's purchasing of green alternatives in goods and services and to embed green purchasing into the organization in partnership with the City's Public Works–Environmental Services Division. To eliminate the use of paper for managing solicitations by moving to an entirely electronic process.

Initiatives and Activities: The City's award-winning green purchasing program has "greened" structural and landscaping pest control, custodial supplies, office supplies, certain computer and monitor standards, and copier and printer performance requirements. We have eliminated the use of certain plastic products and pesticides prohibited by City policy, and made significant strides to reduce pollutants such as mercury and dioxins that are associated with the purchase of City supplies.

Top Three Sustainability Initiatives in 2015

Sustainability Initiative	Objective	Outcome
1. Develop 2015-2017 green purchasing goals, objectives, tasks and timeline to further embed Green Purchasing Palo Alto operations.	Develop a three year plan building on efforts of previous years' work. Develop "default to green" options where appropriate.	Drafted a three year plan (2015-2017) which includes green purchasing goals, objectives and a timeline. *See supplemental materials for plan timeline, recommendations and related policy.*
2. Continue to iteratively green prioritized goods, services and purchasing operations.	Prioritize high-dollar and high carbon footprint purchases, and target opportunities to reduce waste, pollution and maximize energy efficiency.	1. Increased the purchase of green office supplies via Staples contract and blocked key items from purchase on this contract including: foam foodware, pesticides, virgin copy paper and antibacterial soaps. 2. Configured online purchasing of office supplies to simplify and encourage the purchase of 100% recycled content copy paper and remanufactured toner cartridges. 3. Began process to improve copier contract to improve performance of required preset duplexing.

		4. Began RFP for less-toxic structural pest control; 5. Close to adopting a Managed Print Services model for refreshing the City's copier/printer fleet in an effort to move towards both a print-less environment and a more efficient system of copier/print usage.
3. Implement eProcurement	Use new eProcurement system to build in green purchasing objectives into solicitations and reduce paper use and storage.	6. Began effort to research options for using existing SAP program to flag priority products and services to better measure performance and automate more administrative processes.
4. Urban Sustainability Director Network Green Purchasing Grant Partnership	Collaborate on nation-wide grant to identify best practices for all aspects of public agency green purchasing.	7. Final report will be completed in 2016 and Palo Alto will review opportunities to update best practices.

Data: Data hasn't been analyzed, but partial data is available, via Staples.

Challenges: Despite strong leadership from ASD and Public Works staff, this initiative lacks dedicated budget and there are limited staff resources.

Current reporting systems, both from vendors and internal, don't provide sufficient information to evaluate and manage the initiative.

Supplemental Materials:
Please see attached:

- Green Purchasing Recommendations
- 2015-2017 Green Purchasing Workplan
- Green Purchasing Policy

Department Name: Community Services Department

Background: The Community Services Department (CSD) manages 37 parks, a golf course, and open space preserves totaling 4,165 acres of land. Other public facilities managed by CSD include three community centers, a public art center, Junior Museum and Zoo and Children's Theatre. Parks, open space preserves and other outdoor public spaces provide numerous opportunities to incorporate sustainable practices such as water conservation, replacing turf with drought tolerant plants, removing and preventing the spread of invasive plant species, and reducing waste.

Strategy: Working alongside other City departments, such as planning, public works, and utilities, CSD strives to manage and operate parks, open space, and other public spaces using sustainable practices whenever possible.

Goals:

1. Maintain a 35% reduction in potable water use in the City's parks and open space areas.
2. Manage vegetation in parks and open space areas to ensure invasive species are controlled and amount of tree canopy is not reduced.
3. Incorporate sustainable best practices into parks and open space operations and maintenance.

Initiatives and Activities: CSD staff reduced the potable water use in our parks and open space areas by 35% (based on 2013 base year).

In partnership with Save the Bay and volunteers, over 20,000 pounds of invasive weeds were removed from the Baylands and 8,000 native plants were planted.

In partnership with Canopy, 135 native trees were planted throughout the City of Palo Alto's parks.

Top Three Sustainability Initiatives in 2016

Sustainability Initiative	**Objective**	**Outcome**
Promote restoration of native species and habitats in ecosystems degraded by invasive plants.	Continue to partner with environmental organizations to remove invasive plant species, grown and plant native plants, and maintain or increase tree canopy within parks.	CSD partners with environmental organizations to appropriately manage and maintain vegetation in parks open spaces, and other public areas.
Provide opportunities for environmental education	Provide volunteer opportunities, and offer summer camps.	CSD partners with environmental organizations to provide volunteer opportunities. CSD offers programs and summer camps to educate and increase environmental awareness to the community.
Include a sustainability policy in the Parks, Trails, Natural Open Space and Recreation Master	Incorporate sustainable best practices, projects, and/or programs to ensure the policy	Master Plan is anticipated to be complete by December 2016.

Plan	can be achieved.	

Challenges: It can be a challenge balancing the recreation needs of the community with sustainable best practices because the perception is they do not always complement one another. One example of this is replacing grass turf areas with drought tolerant plants or dirt. This may be perceived as a lack of park maintenance, but it is actually the result of a well-planned decision to reduce water usage in areas that are not heavily used for recreation, or could support other types of uses such as gathering spaces or nature walks.

Department Name: Development Services

Background: Development Services is committed to the design and construction of high-performance green buildings that reduce the impact on natural resources and provide healthy environments to live and work.

Strategy: Development Services will continue to provide leadership in the area of green building programs and enforcement protocol. We will develop green building policy for new and existing building stock that leads the State in incorporating high performance, resource efficient buildings, net-zero energy and carbon neutral strategies, and encouraging deconstruction and recycling of construction waste. Our policies, programs, and incentives will promote energy, water, and resource efficiency across our community, resulting in occupant comfort, better indoor air quality, and better environmental quality.

Goals: Our goal is to reduce water use, energy use and GHG emissions by permitted buildings by 10% over prior year data. Our target equals a total energy use reduction amount of 4.3M kBTu/year, 10.5M gallons/year of water, and 99.0 metric tons of CO2 (compared to 2015 performance data reported below). Also, we have a target to reduce energy use of buildings while promoting local generation to offset what is left to achieve Zero Net Energy consumption over the course of a year. We have published a green building survey to better track these building metrics related to building permit applications.

Initiatives and Activities: Deliver interdepartmental training enabling all development review staff and community to answer basic green building questions to the community. Gain approval on two sustainability ordinances related to green building, including the green building ordinance and the energy reach code ordinance. Continue to meet with Green Building Advisory Group for future code cycles and to resolve issues from previous review cycles. Publish a streamlined website promoting design clarity in green building policy and enforcement expectations.

Top Sustainability Initiatives in 2015

Sustainability Initiative	**Objective**	**Outcome**
New Green Building Ordinance	Expand and update the existing green building ordinance with new criteria that reflects current building technology.	Adopted a new Green Building Ordinance, June 22, 2015. An updated version will be presented to City Council in 2016 to coordinate with the 2016 Building Code change.
New Energy Reach Code	Conduct a cost-effectiveness study enabling the requirement of enforcing a 15% improvement beyond the energy code.	Adopted a new Energy Reach Code, September 10, 2015. An updated version will be presented to City Council in 2016 to coordinate with the 2016 Building Code change.
Training and Outreach	Solicit input on future building code amendments, enforce existing codes, and support awareness and	Successful outcomes include improved code compliance and increased capacity from our

	compliance with existing codes.	community partners.
Electric Vehicle and Photo Voltaic (PV) Installation Permitting Streamlining	Process to move from over-the-counter permitting to on-the-web.	This function is being implemented as a part of Accela Work Plan.
Study PV as Default for New Construction	Explore feasibility of developing "default to solar" codes and policy.	The new Energy Ordinance will focus on energy efficiency with solar power as a method for compliance.
Conduct Feasibility Study for Electrification	Explore feasibility of building code changes related to electrification.	Present an update on the Electrification Study at end of 2016 in accordance with the Electrification Study work plan.

Data: FY 2015

Green Building						
Performance Measure	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**
Green Building - revenue $	$25,808	$73,895	$94,113	$127,186	$89,911	**$304,625**
Green Building valuations with mandatory regulations $	$81,238,249	$187,725,366	$543,237,137	$569,451,035	$349,128,085	**$537,328,177**
Green Building square feet with mandatory regulations	774,482	1,249,748	1,342,448	2,441,575	3,432,025	**3,982,319.97**
Energy savings (kBtu/yr) (sf)	449	3,399	1,701	1,922,532	3,141,510	**3,958,713**
Water reduction (gallons/yr)	84,539	2,119,485	4,976,775	5,580,485	7,730,840	**31,285,192**
CO2 emissions reduction (metric tons)	1,013	2,818	21	19,269	72,168	**103,270**

Challenges:

- Development Services faces continuous change in the area of state, local, and federal policy—particularly policies that don't align with the specific needs of Palo Alto.

- California Energy Commission regulates how aggressive agencies can be in their pursuit above minimum code. To affect significant change and meet our GHG reduction goals, new legislation is needed. Development services is working with CPAU, NRDC and other cities to work with the CEC to develop potential regulatory or legislative changes more appropriate to Palo Alto's carbon neutral electricity environment.
- Maintaining an educated community of city staff, local architects, and contractors is a concern that impacts our green building and energy policy.
- Development Services will be rolling out a comprehensive green building training protocol to address this challenge amongst staff and the community.
- Cost effectiveness analysis that accounts for environmental costs needs to be performed to support reach codes.

Department Name: Library

Background: The Library provides educational opportunities that provide the public with information and resources for reducing carbon footprint, waste, energy use, and making improvements to home and habits that encourage such a lifestyle.

Strategy: Library buildings include information about energy use and conservation, model new thinking regarding public building design, and sustain materials collections that aid customer education about all aspects of sustainability and the environment. For example:

Mitchell Park Library: building design as an example of sustainable building practices; architect-developed system of "ecoglyphs" (symbols to lead to discovery of conservation/sustainable systems), and other educational signage to teach while observing/experiencing the environment

Awards for MPLCC in 2015:

Excellence in Facility Design	California Park & Recreation Society
Site Design & Low Impact Development	Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)
LEED Platinum	USGBC
Library Journal Landmark Library	*Library Journal* Magazine
Sustainable Design	City of Palo Alto - Architectural Review Board

Children's Library: heating/cooling guide on screen

Rinconada Library (formerly Main Library): building improvements from renovation to HVAC system and incorporation of improved furnishings

Goals: Specific quantitative targets, where appropriate, described in terms of resource efficiency metrics, GHG reductions, or other relevant indicators. (max 250 words)

Initiatives and Activities: PACL continues to host events and provide programs to all ages that passively or purposefully provide examples to demonstrate some aspect of sustainable practices. For example, nearly all crafts programs incorporate reuse of materials.

2015 Library Programs supporting Earth Day-related activities/goals

5/15: Family Date Night: featured the value of gardening for families

5/26-6/9: Jr. Naturalists, in collaboration w/Environmental Volunteers: met at Rinconada Library with topic of "exploring the earth in the backyard"

5/30: Co-sponsored a talk with Acterra, several local congregations that are part of Peninsula Interfaith Climate Action, and California Interfaith Power and Light, to present author Mary Pipher's as a kick-off to an "All City Read," sponsored by the City of Palo Alto Library, reading *The Green Boat: Reviving*

Ourselves in Our Capsized Culture. Book discussions were held 6/4, 6, 12, 15 at different library branches.

6/23: Island Press author Richard Willson discussed his new book, *Parking Management for Smart Growth*, and ideas and solutions to parking issues that Palo Alto and other cities face.

12/17: Program titled "Replace Your Lawn with California Native Plants: Are you looking for some alternative gardening ideas during our drought?" The California Native Plant Society presented ideas to keep a no-water lawn and landscaping.

Monthly beginning in late 2015: Master Gardeners of Santa Clara County meet at the library

Top Three Sustainability Initiatives in 2016

Sustainability Initiative	**Objective**	**Outcome**
Participate in Silicon Valley Reads 2016 (siliconvalleyreads.org): "Chance of Rain: The Impact of Climate Change in our Lives" Palo Alto City Library is pleased to be participating in Silicon Valley Reads, an annual community program that selects books focused on a contemporary theme and offers free events throughout Santa Clara County to engage the public in reading, thinking, and discussing the topic. In 2016 Silicon Valley Reads focuses on climate change and introduces an emerging literary genre, eco-fiction (also called climate fiction), with two outstanding books that speculate about a future with extreme weather: *Memory of Water* by Emmi Itäranta and *Sherwood Nation* by Benjamin Parzybok. Two books for children have also been selected: *The Storm in the* Barn by Matt Phelan and *Water is* Water by Miranda Paul. The program runs February-March 2016.	Education opportunities regarding drought and need for water conservation	Multiple programs and author visits, leading to community conversations and reflection about water, as well as increased awareness about the importance of water to our daily lives. Programs currently scheduled: • *Creative Ecology*: Linda Gass, a textile artist, gives a talk on her interest in art, ecology, and education @ the Palo Alto Art Center. Jan 13, 7pm. • *SVR 2016 Film Series*: Screening of *Water Detectives* @ 3:30 pm; *Mega-drought* @ 4:00 pm; *Earth Under Water* @ 5:00 pm. Feb 13 @ Rinconada Library. • *Success with Low-Water Ornamentals*: presented by Master Gardeners of Santa Clara County. Feb 18, 7pm @ Rinconada Library. • *Silicon Valley Reads Author Visit:* Emmi Itäranta will visit the Palo Alto City Library to discuss her book, *Memory of Wa-ter*. Mar 6, 2pm @ Rinconada Library. • *Water Cycle Storytime & Craft*: A reading of Miranda

		Paul's *Water is Water*. Tues, Mar 8 & Wed, Mar 9, 10:30am @ Children's Library. • *Brown Bag Book Club*: Book group will discuss *Memory of Water*. Mar 8, 11am @ Rinconada Library. • *RainDance: Using Recycled Water*: RainDance is a Palo Alto company that helps California home owners use recycled water for gardening. By reducing the use of tap water, the company enables gardeners to enjoy the beauty of their land-scape all year long. Mar 10, 7pm@Rinconada Library.

Challenges: The Library's books are still shipped from other systems and within the Library's system, relying on vans that depend on fossil fuel. The Library, while using energy efficient equipment, nevertheless relies on automation which requires high energy usage. Additional open hours of service to the public also increase the number of hours for energy use.

Department Name: Office of Emergency Services (OES)

Background:
The Office of Emergency Services works with all City departments as well as the community to promote resilience to threats and risks of all types.

Strategy & Planning:
The mission of the Office of Emergency Services is to prevent, prepare for and mitigate, respond to, and recover from all hazards. These hazards were recently codified in the Threat and Hazard Identification and Risk Assessment (THIRA) that was presented to City Council in September 2014 (www.cityofpaloalto.org/thira). The THIRA lists a number of hazards that either directly (criminal sabotage or cyber attack) or indirectly (storm that knocks out power) could endanger critical utilities and fuel supplies. The FEMA THIRA best practice structure also encompasses the "technological or accidental" type of incident, such as occurred in February 2010 when the small aircraft collided with the City's connection to the power grid.

There are a number of City plans and related documents that bear on this topic. The Continuity of Operations Plan (COOP) (pending) will address means of keeping the City's government in operation in the event of disruption of City facilities, including utility-related scenarios. OES has also drafted an Energy Assurance Plan (EAP) with the *pro bono* assistance of consultant Arrietta Chakos.

Palo Alto is required to revise the existing Local Hazard and Adaptation Mitigation Plan (LHMAP, formerly LHMP), with State and FEMA approval, and Council adoption no later than 1 June 2017. The LHMAP process will interface with S/CAP and the City's Comprehensive Plan.

Goals:
OES is working with the Chief Sustainability Officer, the Public Works Department, Utilities, and other staff to 1) bolster resilience for key facilities, 2) develop vehicles and systems that are resilient and adaptable to energy disruption, supply chain problems, and other emergencies, 3) community engagement and public safety education, and 4) explore strategies to leverage "green" initiatives to support and realize emergency preparedness objectives.

Initiatives and Activities:

<u>Critical Facilities</u>:
OES is evaluating practical and cost-effective means to expand the use of renewables to reduce the risk of power disruption for certain facilities. For example, the Cubberley Community Center is an important resource in the event of a major earthquake or other disaster, since it 1) houses the Red Cross shelter, 2) is an identified site for medical care by the City's Medical Reserve Corps (MRC), 3) is a back-up location for certain City departments per the Continuity of Operations Plan (COOP), and 4) is the location of the City's Emergency Services Volunteers Division Operations Center (ESV DOC). OES retained an outside expert to evaluate the existing photovoltaic (PV) grid-tied panel system and propose a design to add battery back-up capability, so that certain locations and systems at Cubberley would remain operational even in a grid-down scenario.

Future key facilities include the proposed new Public Safety Building (PSB), which may incorporate microgrids, islanding, and other alternative energy elements to reduce dependence on 1) the power grid and 2) diesel fuel for generators, especially during prolonged incidents.

Vehicles and Portable Renewable Generation:
OES has designed, developed, and now operates a number of vehicles and portable equipment, such as the Mobile Emergency Operations Center (MEOC). OES is investigating solar-battery generator trailers as a means to similarly improve energy resilience for those key assets. OES is even seeking to acquire an all-electric All Terrain Vehicle (ATV) for rescue operations and routine use (which could be the City's first-ever non-fossil-fueled public safety vehicle).

Community Engagement and Public Safety Education:
In addition to these energy assurance efforts, OES leads a number of other community resilience efforts, including the Emergency Services Volunteer (ESV) program that encompasses CERT, Neighborhood Watch, and other programs (www.cityofpaloalto.org/emergencyvolunteers), support of Stanford University and affiliates (such as Stanford Hospital), regional public safety planning efforts, regional training programs, coordination with private sector entities for emergency response and recovery, technology development for public safety, grant management, and other all hazards activities. OES believes that the development of local resources, including, for example, locally-grown farm-to-table food (Victory Gardens!), is not only good for the environment but will help us through a crisis.

Leverage Environmental Initiatives and Maximize Value for Community Risk Reduction and Emergency Preparedness:
The City and others have made and plan to make substantial investments to reduce greenhouse gasses, etc. OES seeks to assist by providing input from a public safety perspective to facilitate a more complete understanding of the consequences and potential risks of certain strategies on the one hand and to maximize the full value of such investments.

The push to increase electric home appliances, for example, has a number of nuances. Those residences with gas appliances (stoves, hot water heaters[1]) can still use them even during a power outage. Increasing electric vehicles (EV) can create hazards (electrical problems when charging; potential risks to first responders dealing with EVs in accidents, etc.) that will need to be understood and addressed.

This is certainly not to say such strategies should not be explored, but rather that the full spectrum of pros and cons should be evaluated. In many cases, there could be creative work-arounds. For example, a resident could install a new electric water heater in parallel to the legacy gas water heater, idling the gas water heater unless/until electricity fails.
There may be some genuine opportunities for "big thinking" in terms of resilience. Palo Alto is unique in having its Utilities, dating back over a century to a time, originally, when the City also controlled electrical generation. Imagine the benefits to residents, businesses, and others were the City and its residents to again own a significant part of its electrical generation capability locally, mitigating the risk of grid failures, future pricing and commodities uncertainty, and so forth.

Put another way, which is more worthwhile: an investment of >$100 million in a second connection to the power grid more worthwhile? or developing local electrical power generation?

Challenges:

[1] Old-school tank hot water heaters have an additional advantage after an earthquake or other disaster where the water supply to a residence is impaired: It can be used as an emergency water source.

The Office of Emergency Services should be viewed a source of expertise, creative ideas, and operational experience. Improved interdepartmental cooperation is needed to implement safety programs that interconnect across City Operations.

Department Name: Planning and Community Environment 2016

Background: The Planning and Community Environment (PCE) Department is responsible for a range of planning and implementation actions aimed at preserving and enhancing the quality of life in Palo Alto, ensuring wise transportation investments, and facilitating land use and development decisions through consistent and transparent processes. The department is responsible for:

- Updating, maintaining, and overseeing compliance with the City's Comprehensive Plan
- Monitoring and enhancing the City's transportation infrastructure
- Implementing a variety of transportation programs aimed at reducing reliance on the private automobile and improving safety for all modes of travel
- Gathering and analyzing data in support of land-use and transportation policy
- Reviewing commercial and residential applications for planning entitlements for compliance with the City's zoning ordinance and applicable guidelines
- Reviewing projects for potential environmental impacts on the City and its residents
- Administration of the City's Community Development Block Grant (CDBG) programs
- Management and implementation of the City's Housing Programs
- Oversight and implementation of the City's Historic Preservation Ordinance
- Investigating and abating code violations

Strategy: 1-2 year: Prepare an update to the Comprehensive Plan for Palo Alto with active community input, addressing issues related to land Use and community design, transportation, climate change and sustainability, safety, noise, natural environment, community services and facilities, business and economics, governance, housing

Goals: PCE's goals for the current year are:

- Incorporate the concept of sustainability into the Comprehensive Plan where appropriate and align with the stand-alone Sustainability/Climate Action Plan that is being prepared concurrently.
- Define and analyze a "Quality of Life" scenario for inclusion in the Comprehensive Plan Update Environmental Impact Report (EIR), incorporating policies and programs consistent with the evolving Sustainability/Climate Action Plan.
- Implement transportation programs to address traffic congestion and parking demand generated by single occupant vehicles including a paid parking study and implementation of parking management programs (e.g. RPP), creation and support of a Transportation Management Association (TMA), and development of strategies to enhance shuttle service.

Initiatives and Activities: Top Sustainability Initiatives in Progress

Sustainability Initiative	Objective	Desired Outcome
Comprehensive Plan Update	Align the Comp Plan Update with the Sustainability/Climate Action Plan that is being prepared concurrently	Analysis of a "Fifth Scenario" for inclusion in the Comp Plan EIR that would implement the S/CAP and address quality of life issues.
Free Shuttle Service	Identify ways to increase ridership by improving and/or expanding	Strategies are being developed to increase trip frequency and

Sustainability Initiative	Objective	Desired Outcome
	shuttle service in Palo Alto	ridership, and conduct community outreach (1 year planning phase)
Parking Management	Better manage parking supplies to meet the needs of residents, visitors/customers, and employees, while providing incentivizes for non-SOV trips.	Implementation of RPP, Implementation of parking wayfinding, completion of a paid parking study, and evaluation of technologies to improve management of parking in commercial districts (2 year planning phase)
Transportation Management Association support	Support activities of the new TMA to reduce SOV trips to/from downtown	Provide incentives to businesses, residents, and the regional community (3 year planning phase)
Housing Element Implementation	Support the development of housing as outlined in the City's Housing Element	Consider ways to stimulate additional ADU that are compatible with Palo Alto neighborhoods, as well as micro units and other types of multifamily housing. Also develop an ordinance providing incentives for small lot consolidation as called for in the Housing Element, and consider whether to eliminate sites along San Antonio Road and substitute greater densities or new sites in transit accessible areas with neighborhood services like Downtown, Cal Ave, or the El Camino Corridor. Update the City's housing impact fees.
Transportation Impact Fees	Assess the best way to ensure that new development does not contribute to cumulative traffic congestion, and design a new impact fee program to eliminate or offset new trips to the extent feasible.	Develop a new transportation impact fee program concurrent with the Comp Plan Update, consolidating existing programs to the extent feasible, and addressing the impacts of new development via TDM, transit, and other trip=reduction strategies.

Challenges:

PCE recognizes the importance of its sustainability-related initiatives, and has been challenged to hire the staff needed to implement these programs. In addition, the schedule for the S/CAP has lagged behind the Comp Plan, which is itself taking longer than originally anticipated. Therefore, it has been challenging to align the policy framework of the two plans as well as the quantitative analysis of GHG emission reductions.

PCE has not had the resources to gather and track meaningful metrics and is currently developing (especially for mobility issues like transit, mode shift to cycling or walking, and parking) a data management system to provide quantifiable evidence for program effectiveness and outcomes.

Supplemental Materials: For more information about the work being done by PCE to guide the preservation and development of Palo Alto, please explore the website to the Comprehensive Plan:

Our Palo Alto 2030: http://www.paloaltocompplan.org/

Department Name: Public Works – Engineering Services & Public Services

Background: The Public Works department is committed to building, managing and operating City buildings and infrastructure in a sustainable manner. This includes libraries, community centers, theatres, fire stations, the Regional Water Quality Control Plant, offices and other buildings, parks, athletic fields, roads, bridges sidewalks and the Urban Forest. Sustainable practices are incorporated into major building renovations, maintenance, infrastructure projects and everyday work practices.

Strategy: Public Works assesses the performance of City-owned facilities, identifies areas for improvement, and develops phased improvement programs to be optimized through monitoring energy and resource use to provide high quality service to the Palo Alto community. Optimization is achieved through improved building management systems and regular assessments of these systems.

Goals: The overarching operational objective of Public Works is to design, construct and renovate efficient and healthful City facilities and infrastructure, operate and maintain them in good order for the comfort and productivity of occupants and users. By optimizing operations, the department seeks to reduce operating costs and negative impacts and improve the reliability of the building systems through continuous improvement of resource efficiency, and to extend the useful life of the buildings consistent with these goals.

Initiatives and Activities: Through various Capital Improvement Projects, Public Works is working to use energy more efficiently and reduce water usage. Parks renovations include drought-tolerant landscaping and trees and more efficient irrigation systems. Building projects are utilizing efficient LED lighting, more efficient HVAC systems, cool roofing materials, and water saving fixtures. Street resurfacing and related concrete work are utilizing recycled aggregates and other waste products such as tire rubber and fly ash. We are following the best business practices for recycling of construction related debris on all projects, and evaluating opportunities for salvage of materials. Storm water pollution measures are being implemented in building, parks and street projects.

Public Works is incorporating “green infrastructure” in all applicable projects. Green infrastructure is defined as storm drain and other water capture infrastructure on public and private lands (including roads and parking lots) that includes low impact development such as infiltration, biofiltration, and/or storage and use of best management practices to collect, retain, or detain stormwater runoff to limit the discharge of pollutants from streets to the storm drain system. Green infrastructure provides amenities with many benefits beyond water quality improvement and groundwater replenishment, including creation of attractive streetscapes, habitat, reduction of heat island effect, and bicycle and pedestrian accessibility. Palo Alto has completed a Green Infrastructure project in the Southgate Neighborhood. We have installed full trash capture devices on Storm Drain mains identified as potentially having high trash content on Park Boulevard at Ventura Ave and a second location at Park Boulevard.

The City’s stormwater discharge is permitted by the Municipal Regional Stormwater Permit (MRP), a regional permit covering 76 Bay Area municipalities. The permit was just reissued and includes requirements for Green Infrastructure planning and development. The permit includes requirements to develop a Council-approved framework, a mechanism to prioritize projects and criteria, a list of

prioritized projects, design guidelines/standard specifications, ordinance changes, and a funding plan. The permit also requires an update of relevant planning documents (such as comprehensive plan, specific plan, transportation plans, storm drain master plan, pavement work plan, and urban forestry plan).

Top Sustainability Initiatives in 2015

Sustainability Initiative	**Objective**	**Outcome**
Benchmark City buildings for comparison of resource use and cost	Utility Track Software has been acquired and installed in Facilities Management. Staff will create benchmarks and compare with similar buildings in the state and the nation, and identify and prioritize opportunities for improvement.	This information will be shared with Engineering Services to identify opportunities for improvement.
Construction of Mitchell Park Library and Community Center (designed for LEED Platinum certification) and the Renovated and Expanded Rinconada Library	Create new or renovated library and community center space that is energy efficient using sustainable building practices.	Construction of both projects was completed in 2014. The Mitchell Park Library and Community Center was awarded a LEED Platinum certification in 2015. Rinconada Library is in process, with the facility expected to achieve LEED silver certification.
Water Efficiency Efforts	Reduce use of potable water in construction activities	New specifications were incorporated into Public Works construction projects requiring use of recycled water for dust control and other applications. Substitution of recycled water for dust control and grading activities at the El Camino Park Restoration project alone saved 250,000 gallons of potable water. New requirements for basement construction dewatering were implemented in 2015, providing "fill stations" at each of the 14 dewatering sites that allowed filling of water trucks and use by neighbors of shallow nonpotable groundwater that is otherwise discharged to the storm drain system.

Implementation of Title 24 Building Energy Efficiency Standards	Sustainable work practices for building system maintenance include improvements in mechanical, electrical, and plumbing systems.	Mechanical improvements include the use of cool roofing materials to meet Title 24 Building Energy Efficiency Standards, replacing air conditioning units with more energy efficient units (when existing units need replacement) and using Building Management Systems (BMS) to control and monitor and mechanical and electrical equipment (including lighting) via computers in some facilities. Electrical improvements include the use of LED lighting, the use of occupancy sensors, and bi-level lighting for parking garages. Plumbing improvements include the use of low flow urinals and low flow toilets.
Park Renovation Projects	Park renovation projects managed by Public Works incorporate sustainable landscaping and turf elimination to conserve water whenever possible.	The El Camino Park Restoration project was completed in 2014. This project incorporated a new artificial turf playing field that is expected to save approximately two million gallons of water annually. The project also included a new 10-foot wide bike path with 5,500 square feet of pervious concrete to allow on-site infiltration of rain water.
Procurement and Use of Environmentally Preferable Construction Materials	Street resurfacing projects include recycled aggregate in the asphalt mix and base rock.	Major arterials are being paved with rubberized asphalt utilizing recycled tire rubber. Sidewalks, curbs and gutters are replaced with concrete that contains approximately 25% fly ash by volume. Paving work on Alma Street and Middlefield Road in 2015 used 1,865 tons of rubberized asphalt.
Procurement and Use of Environmentally Preferable Consumables	The City uses sustainable purchasing guidelines.	City facilities are cleaned with environmentally friendly Green Seal Certified cleaning chemicals

		and no chlorine and post-consumer content paper towels are supplied in restrooms. Pest management also focuses on prevention and then using non-toxic pesticides.
Develop a City wide facilities energy management plan	Development of an energy management plan to guide the acquisition and installation of energy conservation measures in City –owned buildings	Begin drafting this plan with input from Engineering Services, Public Services/ Facilities and Environmental Services.
Fleet electrification	Shift fleet from fossil and CNG fueling to EVs, as possible.	Conducted cost-effectiveness analysis; established "EV First" policy, and began replacing vehicles. Evalutating 3rd party leasing options to accelerate fleet electrification

Data:

CY 2014			
Row Labels	**Sum of Electric (kWh)**	**Sum of Gas (Therms)**	**Sum of Water (ccf)**
Buildings and other facilities	11,271,283	431,145	148,492
Other process and fugitive emissions	1,210	0	0
Power generation facilities	380,030	4,292	149
Solid waste facilities	124,524	0	154
Streetlights and traffic signals	665,701	0	3,903
Wastewater facilities	16,582,000	455,748	1,551
Water delivery facilities	686,565	107	15,291
#N/A	2,252	0	72,796
Grand Total	**29,713,565**	**891,292**	**242,336**

Year	**Electricity (kWh)**	**Electricity Cost**	**Gas Usage (Therms)**	**Gas Cost**	**Water Usage (CCF)**	**Water Cost**	**Annual Totals**
2014	29,713,565	$3,126,178	891,292	$938,600	242,336	$1,893,504	**$5,958,281**
2013	28,809,795	$3,193,814	842,020	$832,556	283,943	$2,137,872	**$6,164,243**
2012		$3,331,729		$780,787		$1,650,344	**$5,762,860**

	29,037,416		827,295		230,204		

Challenges: As stated in previous reports, when existing building systems are renovated or replaced, air conditioning is being added where it previously didn't exist. This additional system tends to flatten the overall potential energy savings of the newer more efficient heating systems and lighting. At Rinconada Library, geothermal wells were used to help mitigate this challenge.

Historical preservation requirements are also a challenge. At Rinconada Library, the large grass lawn was a key historic feature of the overall site. It was therefore not possible to convert this to drought-tolerant landscaping and reduce irrigation needs. However, the project installed "purple pipe" so that it can easily be converted to recycled water when that system is expanded throughout the City.

Public Works has completed a third party independent Facilities Management Organizational Study to evaluate the efficiency of our maintenance of Facilities. This study was conducted by Matrix Consulting. In the study, Matrix called out 10 recommendations related to Energy Management. Our newly appointed Facilities Manager will be analyzing these recommendations with the Engineering Services Division in the coming months. Staff anticipates development of new processes related to identification replacements, standards for replacements and use of energy audits.

In this regard, reducing the energy and water usage is an important consideration. Energy and water usage can be tracked through our Utility Track software to determine the impact of efficiency and conservation initiatives.

Department: Public Works– Fleet Division

Overview: The Public Works Fleet Division is responsible for maintenance, repairs, and compliance of all City of Palo Alto vehicles and equipment. The division is charged with meeting all local, state, and federal air pollution requirements and vehicle safety standards. It also conducts the proper disposal of declared surplus and acquisition of replacement vehicles and equipment. The division's mandate is to:

1. Maintain fleet availability by providing the vehicles and equipment to all of the departments daily in order for the departments to be able to provide the services to the City of Palo Alto.
2. Work with all operators, managers and departments, to prevent air pollution by training the drivers on reducing idle time as well as demonstrate the proper and safe use and operation of the vehicles and equipment.
3. Perform preventive maintenance inspections and repairs on a daily basis to all of the vehicles and equipment.
4. Ensure regulatory compliance with the BAAQMD, BAR, CHP, DOORS, OSHA and CAL OSHA.
5. Perform vehicle and equipment usage analysis to be able to identify underutilized vehicles and equipment and recommend right-sizing the number of vehicles and equipment needed in the City of Palo Alto.

Strategy: Improve fleet efficiency and reduce vehicle and equipment emission by electrifying the fleet, maintaining it in top operating conditions, and training staff in safe and efficient operation.

Goals: The Fleet Division is moving toward a low-emission transportation future with these department goals:

1. Identify new technologies and bold strategies to **reduce fleet GHG emissions**
2. **Reduce unleaded fuel consumption by at least 10% each year,** by scheduling replacement of all vehicles older than 10 years with current electric or low emissions models**.**
3. **Meet or exceed all** regulatory requirements for air pollution reduction and air emissions required by BAAQMD, BAR, DOORS, PERP and EPA **while providing an increasingly high level of service to all members of the Palo Alto community.**

Initiatives and Activities: Fleet Services has been replacing gasoline-powered vehicles and other equipment with cars and trucks that use alternative fuels, such as compressed natural gas, or electric vehicles (EV). The City invested in a compressed natural gas (CNG) fueling station at the Municipal Service Center for the 10% CNG vehicles in the fleet. However, choices for vehicle types are limited from manufacturers. We have replaced three vehicles with 2015 Toyota Prius hybrids, running on 87-octane unleaded fuel, replaced one vehicle with a 2016 Ford Focus electric, and have budgeted to replace one more vehicle with a Ford Focus electric in the 2016 fiscal year. We have developed a new policy (early 2015) to preference the purchase or lease for EVs over CNG, where appropriate, to take advantage of the City's carbon-neutral electricity.

Top Sustainability 2014 Initiatives and Activities:

Sustainability Initiative	Objective	Outcome
Reduce Greenhouse Gas emissions	Monitor and reduce GHG emissions associated with vehicles and equipment	• Number of vehicles purchased and gas powered vehicles retired (data in progress) • -15% GHG emissions change from 2005 baseline year through 2014?
Reduce unleaded and diesel fuel consumption in the fleet	Establish policy and procedure for the operators to minimize the idle time on the vehicle and equipment they are using. Reduce the number of vehicles and equipment in the fleet by performing a vehicle utilization analysis and identify those vehicles that could be declared surplus and sold at auction.	The City has established an anti-idle policy, outlined in Policy And Procedures 4-01/PWD, in an effort to reduce vehicle/equipment idle time which will reduce fuel consumption and our GHG emissions. The City also introduced into policy Remote Vehicle Monitoring Systems (RVMS), outlined in Policy And Procedures 4-09/PWD. Specific uses of RVMS will be to ensure proper use of City equipment and promote fuel efficiency. Pool car utilization analysis was conducted and a total of four vehicles were identified as being underutilized. These vehicles are scheduled for surplus in FY 2016. Through fleets efforts over the last two years both diesel and unleaded fuel consumption were reduced in CY 2015.

Data:

Table: Fuel Use by Type (Gallons), 2005-2015)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gasoline	149,861	156,142	152,153	146,398	131,096	137,850	146,595	147,849	146,479	**150,732**	**146,977**
Diesel	97,676	103,888	131,810	131,423	122,341	126,500	134,262	95,036	83,539	**83,535**	**74,557**
Biodiesel (B20)	46,667	27,261	0	0	0	0	0	0	0	**0**	**0**
CNG (City operations)	20,217	18,799	28,197	36,387	36,713	49,948	36,554	40,136	37,854	**24,427**	**15,862**
CNG (PASCO, PAUSD)	44,273	60,928	80,491	88,088	86,786	87,635	85,872	91,125	86,570	**51,492**	**56,405**

Fleet GHG Emissions (Metric Tons of Carbon Dioxide Equivalents, CO_2e), 2005-2014

Fuel Type	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gasoline	1,316	1,371	1,336	1,285	1,151	1,210	1,287	1,298	1,286	1,323	1,290
Diesel	997	1,061	1,346	1,342	1,249	1,292	1,371	970	853	853	761

Biodiesel (B20)	381	223	0	0	0	0	0	0	0	0	-
CNG (City operations)	139	129	193	250	252	343	251	275	260	168	109
CNG (including PASCO, PAUSD)	304	418	552	604	595	601	589	625	594	353	387
Total Emissions (excluding PASCO, PAUSD)	**2,833**	**2,783**	**2,875**	**2,877**	**2,652**	**2,845**	**2,909**	**2,544**	**2,399**	**2,344**	**2,547**
Percent Change from 2005 baseline	-	**-1.80%**	**1.50%**	**1.60%**	**-6.40%**	**0.40%**	**2.70%**	**-10.20%**	**-15.30%**	**-17.3%**	**-10.1%**

Challenges:

Existing fleet fueling data software has undergone a series of upgrades in order to provide better functionality, and data management. With the new software upgrades the reporting capabilities have increased greatly. However, the lack of staff training in creating reports leaves us unable to benefit from the new capabilities at this time. The department is exploring costs for on-site Crystal Reports specific training.

Programs designed for traditional fleet maintenance goals haven't been focused on meeting the bold target of 80% GHG reduction by 2050; the department needs to develop new programs and manage its performance to achieve its incremental annual reduction targets.

Fleet's vehicle replacement program was developed when CNG fueling was the environmentally preferred option; with the advent of carbon-neutral electricity, EVs are now preferred from an environmental perspective. In 2015 staff determined that EV sedans can also be less expensive on a total cost of ownership (TCO) basis if vehicles are leased, and the City Manager established an "EV first" policy. Staff has also been in discussion with vendors offering a turnkey fleet electrification program. However some staff perceive EVs as less desirable replacement options than current model gas-powered vehicles for some service requirements, so staff education and "ride and drive" opportunities will be important to build staff awareness of current options..

Supplemental Materials:

Greenhouse Gas Reduction from Fleet Division: Section 12 in 2015 Clean Bay Plan, available at cleanbay.org.

Reduced unleaded and diesel fuel consumption in the fleet: Section 12 in 2015 Clean Bay Plan, available at cleanbay.org.

Compliance with regulatory and policy requirements to reduce other priority air pollutants in the atmosphere: 2015 CleanBay Plan report, located at cleanbay.org.

Department: Public Works–Watershed Protection & Regional Water Quality Control Plant

Background: The Public Works–Watershed Protection Division in collaboration with the Regional Water Quality Control Plant (RWQCP) works to reduce pollutants entering the Bay through award-winning pollution prevention, pretreatment, stormwater and air management programs. Since 1990, the goals of the RWQCP and Watershed Protection have been to:

1. Treat wastewater from the RWQCP six-community service area of East Palo Alto Sanitary District, Los Altos, Los Altos Hills, Palo Alto, Mountain View, and Stanford;
2. Work with industry and businesses to prevent pollution;
3. Ensure regulatory compliance with the RWQCP wastewater discharge permit, air permit, and the Stormwater Permit; and
4. Provide residential services and education to prevent pollution in Palo Alto's creeks and San Francisco Bay.

Strategy: Given strict stormwater and wastewater permit requirements, Palo Alto must explore all feasible methods of reducing its metals and toxic organic pollutant discharges to San Francisco Bay. After initially focusing on pretreatment programs at major industrial facilities, the RWQCP expanded its efforts to include commercial and residential programs. Strategies include:

- Commercial and industrial: Integrating pollution prevention into business requirements via ordinance and incentives such as the Clean Bay Business Program;
- Residential: Providing programs with collection services for pollutants of concern (e.g., pharmaceuticals and sharps) and extensive public outreach including classroom presentations throughout the RWQCP service area; ongoing informational campaigns coordinated locally, regionally and state-wide; workshops, tours and special events;
- Leverage opportunities to improve and expand recycled water use and infrastructure.

Key 2015 Goals: Watershed Protection had several 2015 goals to reduce industrial and residential pollutants for stormwater and wastewater, including the following higher-profile efforts:

1. Identify strategies to reduce greenhouse gasses (GHGs) associated with wastewater treatment and continue to meet goal of 20% reduction from 2005 emissions;
2. Promote the use of RWQCP recycled water through the Residential Truck-Fill Program, salinity reduction efforts, regional collaboration, and pipeline expansion efforts;;
3. Work towards meeting the 60% trash reduction (volume) target by July 1, 2016 in Palo Alto creeks, streets and Bay shoreline as part of the Municipal Regional Stormwater Permit requirement;

For a complete summary of 2015 pollution prevention efforts see the 2016 Clean Bay Plan report located at cleanbay.org.

***Top Three Sustainability 2015* Initiatives and Activities:**

Sustainability Initiative	Objective	Outcome
1. RWQCP Greenhouse Gas Reductions	Continue to reduce and track GHG emissions associated with wastewater treatment.	1. RWQCP GHG emissions have reduced to 16,608 metric tons of carbon dioxide equivalents (MT CO2e), a 41% reduction since 2005. This reduction marks the continuous achievement of the goal set forth in the 2010 update to the City of Palo Alto's Climate Protection Plan: 20% reduction of City GHG emissions below 2005 emissions by 2012. 2. The RWQCP purchases carbon neutral power from the City's electricity portfolio and since July 2015 has purchased natural gas from the City's green gas portfolio. 3. In early January, 2015, Council approved a contract with CH2M-Hill to design the facilities needed to phase out the City's sewage sludge incinerator as soon as possible and replace it with a dewatering and truck off-haul facility. This is expected to greatly reduce RWQCP GHG emissions. 4. A GHG and Energy Factsheet was created in 2015 to provide concise information regarding historical and projected GHG emissions. Note: For more information, see Section 11 in 2016 Clean Bay Plan available at cleanbay.org.
2. Recycled Water Expansion	Promote the use and expansion of the RWQCP Recycled Water Program as a sustainable and reliable alternative source of water.	1. In 2015, Watershed Protection staff has worked closely with the Santa Clara Valley Water District, the City of Mountain View, and the City of Palo Alto's Utility Department to identify expansion opportunities for the RWQCP's Recycled Water Program. 2. In 2015, City Council approved the Environmental Impact Report for Phase III expansion of the recycled water pipeline. 3. In 2015, the RWQCP expanded its truck-fill program to include residential customers and experienced a 580% increase in active recycled water permits. 4. Watershed Protection Staff, in collaboration with the Santa Clara Valley Water District and City of Mountain View, have moved forward with a feasibility study of enhancing the quality of the RWQCP recycled water by adding an advanced treatment system such as reverse osmosis. An advanced treatment system is expected to significantly decrease recycled water salinity amongst other water quality improvements. 5. RWQCP staff has continued efforts to identify sources of increased salinity from leaking wastewater collection system pipes. Note: For more information, see Section 12 in 2016 Clean

		Bay Plan available at cleanbay.org.
3. Trash Reduction in creeks, streets, and along Bay	1. Meet Municipal Regional Permit performance guideline of 60% trash reduction by 2016 along Palo Alto creeks and shoreline and future requirements of 70% by July 1, 2017 and 90% by July 1, 2019. 2. Expand Palo Alto's Plastic Foam Ordinance to prohibited retail sale or distribution of plastic foam products.	1. In December 2014, The Regional Board confirmed that Palo Alto had met its 40% trash reduction requirement.* The City of Palo Alto reported 60% trash reduction and 71% reduction in the 2015 annual report. The Regional Board reissued the stormwater permit in November 2015 with new requirements. Trash reduction is currently quantified based on on-land visual assessments (i.e. monitoring of trash reduction activity success) and the success of product bans. 2. In December 2015, Council expanded the current plastic foam ordinance to prohibit retail sale or distribution of foam ice chests, foodware, packaging materials and egg cartons. Food service establishments have been prohibited from using plastic foam since 2010. The ordinance will go into effect on March 1, 2016. * More info located in the Long-Term Trash Plan and the 2014-15 Stormwater Annual Report: ** For more information, see Section 7 in 2016 Clean Bay Plan available at cleanbay.org.

Data:

1. RWQCP GHG Emissions Data

The RWQCP GHG emissions stem from the treatment of wastewater collected from the City of Palo Alto as well as its Partner Agencies (Mountain View, East Palo Alto Sanitary District, Los Altos, Los Altos Hills, and Stanford). The RWQCP has five major sources of GHG emissions: electricity usage, natural gas combustion for office heating, sewage sludge incineration (natural gas, landfill gas, and biosolids combustion), biological treatment of wastewater, and baylands conversion of wastewater discharge (Figure 1).

RWQCP GHG emissions decreased by 41% since 2005 mainly due to the purchase of green natural gas beginning in 2015, purchase of 100 percent green power electricity since 2013, use of landfill gas as a replacement for natural gas in the incinerator afterburner since 2005, and decreased incinerator hearth natural gas usage due to regular incinerator tuning (Figures 2).

RWQCP GHG emissions as reported to the California Air Resources Board may differ from the values presented in Table 1 due to different high heat values, global warming potentials, and/or emission factors. RWQCP GHG emissions contained in this report were calculated using a static document, the Local Government Operations Protocol, Version 1.1 (2010) for analysis of historical trends and

reductions; in contrast, the California Air Resources Board has periodically updated their GHG calculation methods to better reflect recent advances in science and federal regulations.

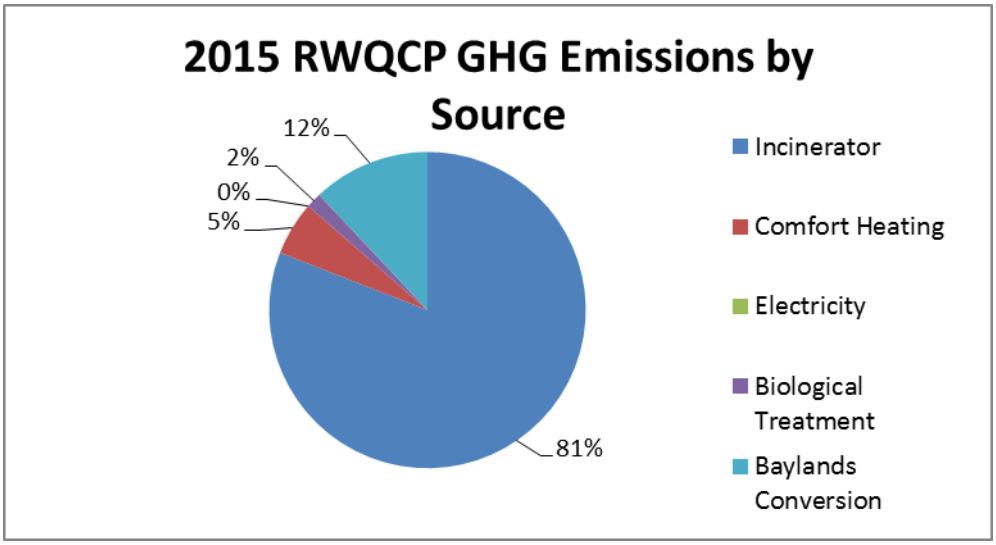


Figure 1: RWQCP 2015 Greenhouse Gas Emissions by Source

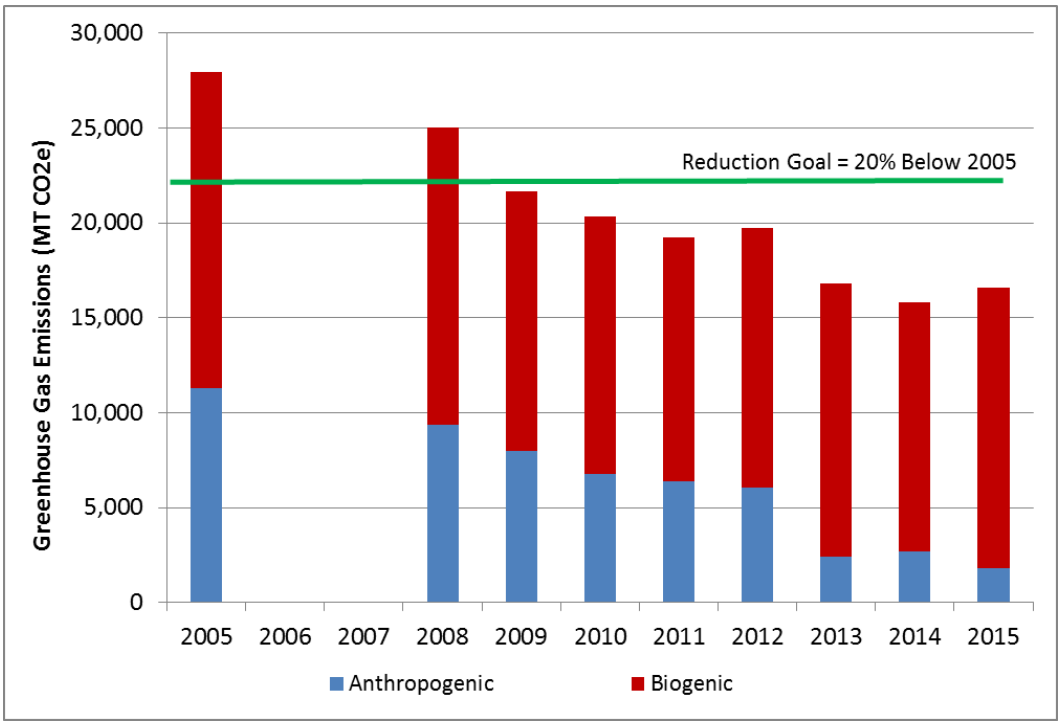


Figure 2: Historical RWQCP Greenhouse Gas Emissions as Calculated by the Local Government Operations Protocol, Version 1.1 (2010)

2. Recycled Water Expansion Data

RWQCP total recycled water usage remained relatively constant from 2014 to 2015 with a slight decrease most likely due to increased water efficiency efforts (Figure 3). Despite the relatively constant total usage of recycled water, active recycled water permits significantly increased (Figure 4). In 2015, 61 active recycled water permits were reviewed and approved for use; this is a 580% increase from 2014 when only 9 recycled water permits were active.

RWQCP routinely monitors the quality of the recycled water it produces for numerous parameters. One such parameter is salinity. Salinity is of particular concern for use of recycled water to irrigate salt-sensitive vegetation (such as Redwood Trees) as well as for use in industrial cooling towers. The RWQCP analyzes Recycled Water salinity using numerous metrics: total dissolved solids (TDS), sodium adsorption ratio (SAR), and specific conductivity. RWQCP and its partner agencies (referenced above in "Background") are taking efforts to decrease salinity entering the RWQCP from their collection systems (Figure 5). In addition, Watershed Protection, in collaboration with the Santa Clara Valley Water District and City of Mountain View, are undertaking a feasibility study for the addition of an advanced water purification system at the RWQCP that would further enhance the recycled water quality, including significant decreases in salinity.

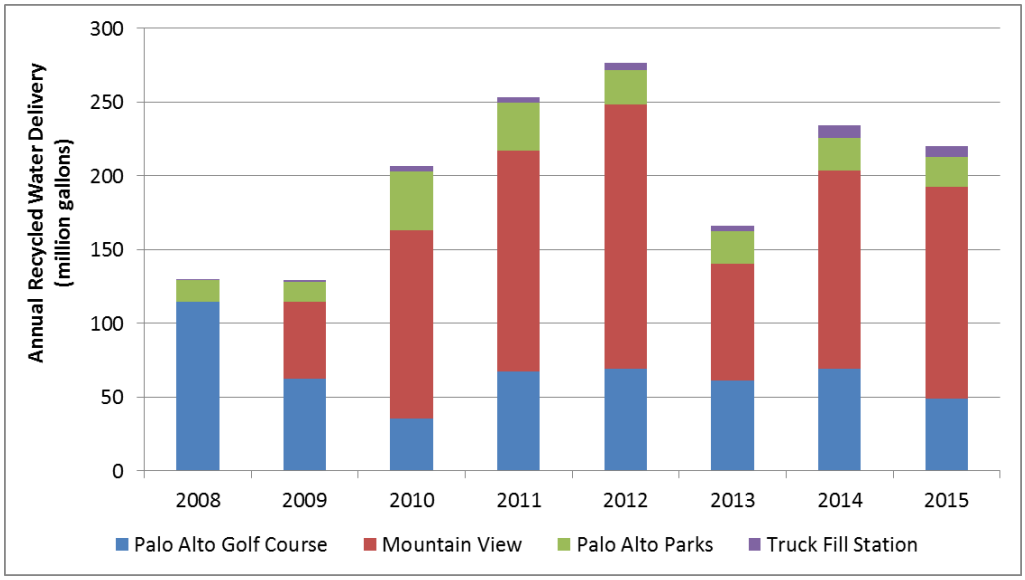


Figure 3: Historical Recycled Water Usage.

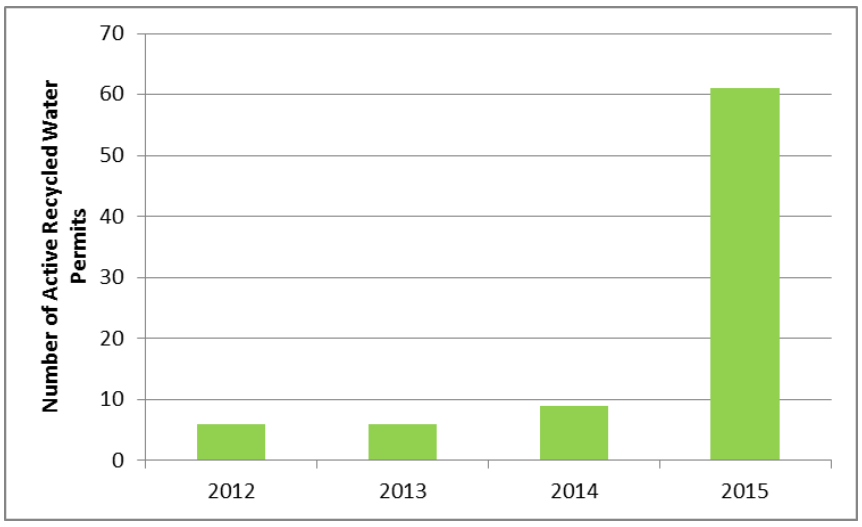


Figure 4: Historical Active Recycled Water Permits.

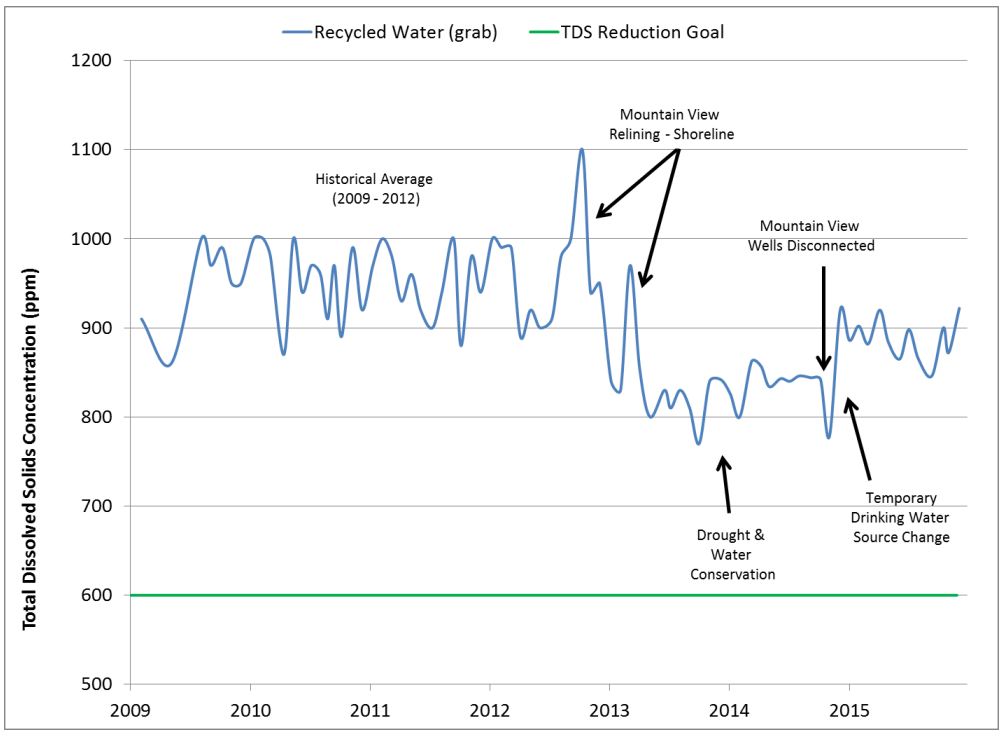


Figure 5: Historical Recycled Water Salinity (total dissolved solids).

3. Continue to meet regulatory requirements for additional pollutant reduction- The RWQCP has many numerical and programmatic regulatory requirements for pollutant reduction. An annual report of compliance and programmatic achievements is provided at cleanbay.org.

Challenges

1. **Future GHG Reductions:** The RWQCP has made large reductions in GHG emissions over the past 5 years due to incinerator tuning, landfill gas replacement of natural gas in the afterburner, aeration basin optimization, installation of variable frequency drive lift pump controls for the trickling filters, as well as purchasing green energy options. As aging or deficient pumps and motors are replaced, the most energy efficient options available will be installed. Ongoing RWQCP optimization will continue, however the major GHG reductions from optimization projects have already occurred. RWQCP GHG emissions associated with biological treatment and baylands conversion are expected to gradually increase overtime as water conservation increases while at the same time the service area population and economy grow. Future GHG reductions will be largely contingent on future plans to phase out sewage sludge incineration expected in 2019, the new biosolids treatment process expected in 2025, and the availability of landfill gas as a replacement for natural gas in the incinerator (Figure 6). Landfill gas is used as much as possible in the incinerator afterburner. However the lower quality of landfill gas requires that natural gas continue to be used in other areas of the incinerator. Additionally, maintenance requirements on the landfill gas collection and distribution system varies from year-to-year and often makes landfill gas unavailable for RWQCP use thus requiring more natural gas be used during those times.

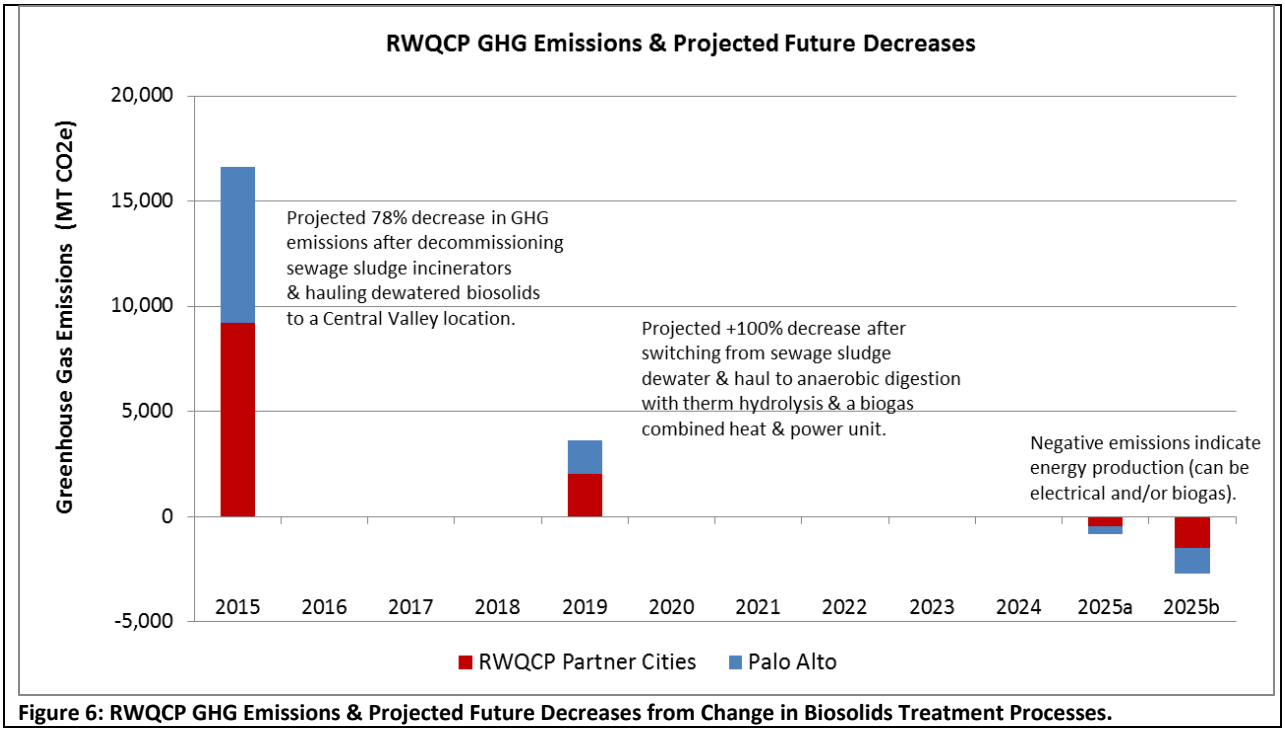


Figure 6: RWQCP GHG Emissions & Projected Future Decreases from Change in Biosolids Treatment Processes.

2. **Drought and Increased Economic Activity:** Drought conditions in the service area have increased water conservation efforts and significantly decreased flows entering the RWQCP (12% from 2009 to 2015). Additionally, the recent economic recovery and growth in the service area (for example the increase in Google employees) increases the daytime population that

increases inputs to the RWQCP from toilet flushing versus more dilute inputs such as showering. Decreased flows combined with increased daytime populations have a combined impact of increased loads and concentrations of pollutants such as ammonia and total dissolved solids (salinity). Higher pollutant loading and concentrations strain the current treatment process that was originally designed for treating more dilute wastewater. This issue is anticipated to pose continued challenges with meeting permit limits and internal goals (such as salinity reduction goals) should drought become more common with predicted climate change.

3. **Recycled Water:** One of the challenges with recycled water is that its quality is very dependent upon the quality of the wastewater that is sent to the RWQCP for treatment. Leaky pipes and transmission lines increase the salinity that must be removed at the RWQCP for future expanded use of the recycled water. Locating and subsequently relining these leaky pipes is challenging and requires not only special evaluations but also cross-departmental collaboration. Another challenge with the expansion of the RWQCP's Recycled Water Program is the required expansion of the recycled water transmission pipelines. Current pipelines are limited to the area adjacent to the RWQCP. Expanding this pipeline is expensive and may not be cost effective depending on the expected demand for recycled water. The last major challenge for the expansion of the Recycled Water Program is the impact from prolonged drought and increased economic activity. Refer to Challenge No. 2 for more details on drought and increased economic challenges.

4. **Trash Reduction:** The primary challenge is measuring the impact the City's programs have on the amount of trash in the creeks and Bay since trash is also transported to creeks and the Bay via wind and direct dumping and not only via the storm drain system. This is a challenge faced by all stormwater co-permittees (the regional stormwater permit is shared by cities in all nine Bay Area Counties). Palo Alto will continue its programs to manage illegal dumping and to provide clean-up events in an effort to address this challenge. The new stormwater permit requires development of tools and protocols for receiving water trash monitoring which will be developed regionally.

5. **Sea Level Rise:** New facilities being built at the plant will have flooring installed at 10.5 feet above Mean Sea Level (MSL), or higher, in addition to plans to construct levees outboard of the Plant at ~ 16 feet above MSL. The levees will protect the plant from a sea level rise of ~ 3 feet.

Supplemental Materials:

The 2016 Clean Bay Pollution Prevention Plan can be found
http://www.cityofpaloalto.org/news/displaynews.asp?NewsID=1527&TargetID=150

Department Name: Public Works Environmental Services Division, Zero Waste and Landfill Operations

Background: The City of Palo Alto adopted a Zero Waste policy in 2005. Since then, the City as a whole dramatically has reduced the amount of material going into landfills. The City now has a waste diversion rate of 80 percent, up from a 63 percent diversion rate in 2005.

The City's solid waste related greenhouse gas emissions stem primarily from two sources: (1) the fugitive emissions from the landfill where materials are buried; and (2) the emissions that are a result from having to mine or fabricate new resources (e.g., aluminum, glass, paper, plastic, etc.) instead of recovering these resources from recycled materials. Simplifying the residential recycling collection process, collecting and composting commercial food scraps, and engaging the community with effective zero waste marketing campaigns, are programs that have helped the City progress towards its greenhouse gas emissions reduction goals as well as zero waste goals.

While economic activity and construction have an impact on the overall amount of material disposed, Zero Waste programs have helped keep tens of thousands of tons of material out of the landfill. In 2008, 68,228 tons were disposed in landfills. By 2014, that amount was reduced to 43,730 tons, a 46% reduction. Many more tons are now recycled or composted at homes, businesses, and construction sites. The amount of recyclable materials collected and diverted from the landfill increased from about 13,000 tons diverted in 2008 to 19,378 tons in 2014. Commercial compost collection, which started in 2009, diverts over 11, 580 tons per year of food scraps and food soiled paper from the landfill. On July 1, 2015, all single-family residential customers could now place food scraps and soiled paper directly into the green, yard trimmings cart as part of the residential curbside compost collection program. For new construction, 75 percent of all material must be recycled or reused on site as part of the City's Green Building Program put into place in 2013, which superseded the Construction and Demolition Debris Ordinance of 2004.

The Palo Alto Landfill is owned, monitored and maintained by the City of Palo Alto. The municipal solid waste landfill operated from the 1930's to 2011 and is now in the closure/post-closure phase. The long-planned end use of the landfill is parkland. The Environmental Services Division in the Public Works Department is responsible for the closure and post-closure care of the landfill. By law, the City is required to monitor the landfill for a minimum of 30 years to assure it does not pose an environmental hazard resulting from the release of landfill gas or the creation/release of *leachate*—the liquid that is created inside the landfill that must be pumped out for treatment at the Palo Alto Regional Water Quality Control Plant (RWQCP). Landfill gas is collected and either combusted in the RWQCP sludge incinerator facility or flared.

Strategy:

The zero waste strategy seeks to eliminate waste wherever possible, and then manage the discards we do create through reuse and recycling. Cities tend to focus on "end of pipe" solutions to recover materials for recycling and/or composting. Palo Alto goes even further by emphasizing the elimination of waste with programs like the food waste reduction program and internal environmentally preferred purchasing policies.

For the landfill, staff has pursued two strategies to reduce greenhouse gas emissions: 1) capping the landfill; and, 2) beneficially reusing the landfill gas.

Goals:

- Achieve a 90 percent diversion rate by 2021.
- Improve consumption habits and reduce the total amount material sent to the landfill.
- Provide local recycling and composting resources.
- Finalize landfill closure and conversion to parkland
- Maximize the amount of landfill gas sent to the Regional Water Quality Control Plant.

Initiatives and Activities:

A Recycling and Composting Ordinance for commercial customers was adopted by Council on January 25, 2016, which would require commercial customers to subscribe to compost service and properly sort both their recyclable and compostable materials. The proposed ordinance– currently planned for early 2016, may yield GHG emission reductions in excess of 22,000 MT CO2e per year.

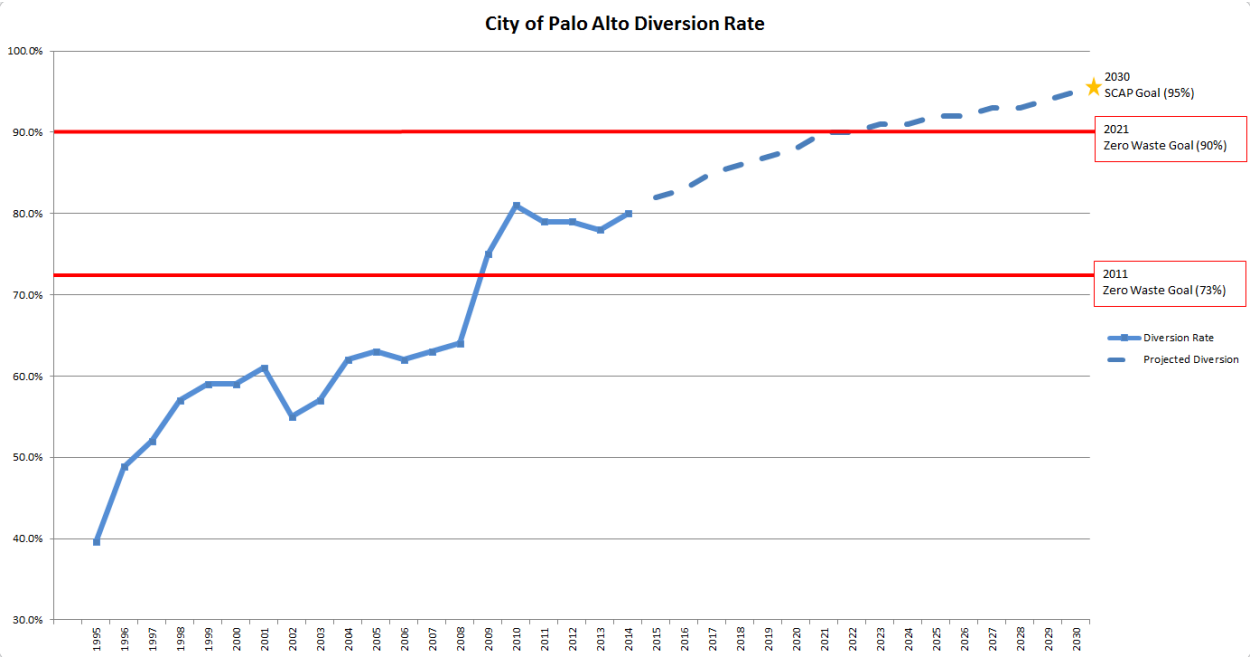
The landfill closure work was completed in November 2015. The closure work included constructing a new alterative design cap called an evapotranspirative cap. Completion of the cap is expected to reduce the amount of fugitive landfill gas emissions. In addition the landfill continues to send landfill gas to the Regional Water Quality Control Plant where it is used in their incinerator. This reduces the amount of carbon dioxide emitted by the combustion of landfill gas.

Top Sustainability Initiatives in 2015

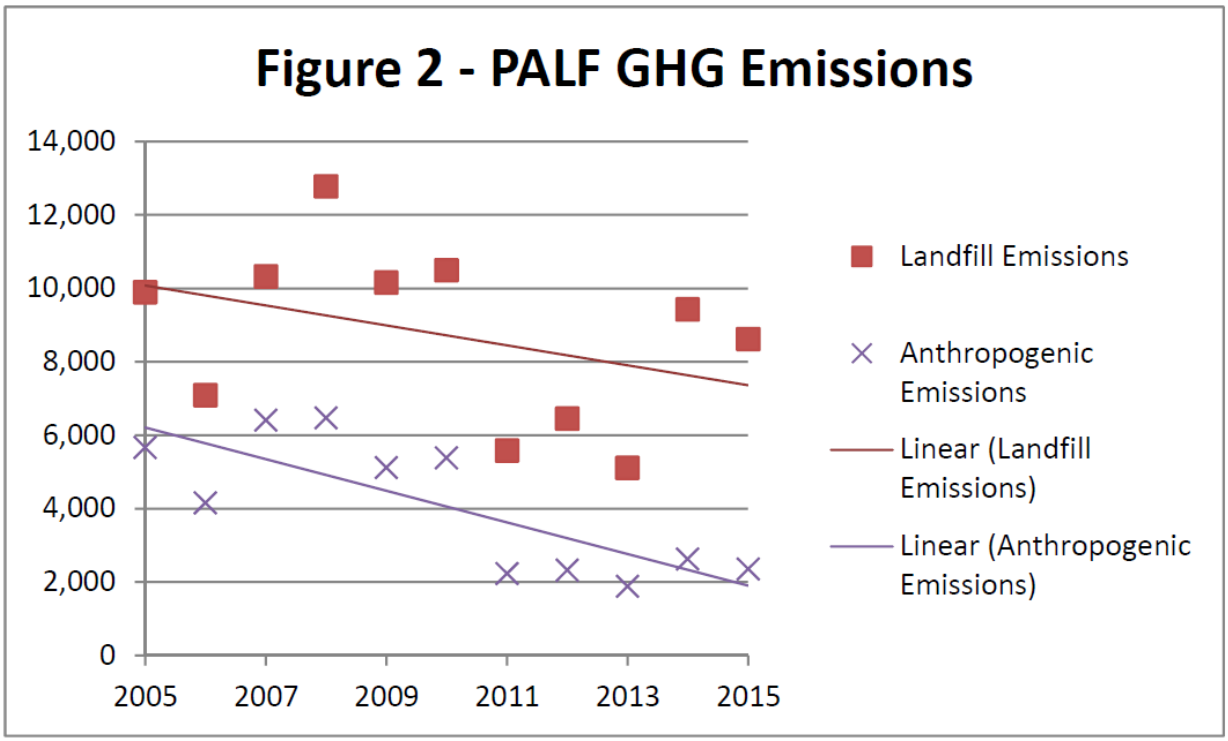
Sustainability Initiative	**Objective**	**Outcome**
Food Waste Reduction program	Deliver outreach messages and tools to residents and businesses on how to reduce the amount of food wasted.	The quantity of waste diverted is not currently measured by the City's implementation partner.
Cap the landfill	Cap the last phase of the landfill (Phase IIC) that will reduce fugitive landfill gas emissions.	The final landfill phase has been capped as of December 31, 2015. All environmental protection systems will be completed in FY 2016.
Increase beneficial reuse of landfill gas	Modify controls at the flare station and incinerator	Better control and metering of landfill gas to the incinerator

Data:

Annual Diversion Rate, 1995-2014



Historical City of Palo Alto Landfill GHG Emissions, 2005 (baseline) - 2015



Overall the trend in the City of Palo Alto GHG emissions is downward. Fluctuations in GHG emissions are likely the result of closure activities. The closure activities include years of decreased waste acceptance followed by a year of increased waste placement, expansion of the gas collection system and completion of cover operations.

Forecast: Solid Waste Related GHG Emissions in metric tons (MT) carbon dioxide equivalents (CO_2e) for the Palo Alto Landfill.

Emissions Source	2016 Emissions	2017 Emissions	2018 Emissions
Palo Alto Landfill GHG emissions during the year	8,600	8,500	8,400

With the completion of the landfill cap and upgrades to the landfill gas collection system the City expects the Palo Alto Landfill GHG emissions to continue to trend downwards over the next 30 years. The rate of the drop in GHG emissions is difficult to estimate this early in the completion of the cap but as time goes on the rate should be more predictable.

Trend: Solid Waste Related GHG Emissions in metric tons (MT) carbon dioxide equivalents (CO_2e).

Emissions Source	2005 Emissions[1] *(baseline)*	2012 Emissions	2013 Emissions	2014 Emissions	2015 Emissions *(current)*	Difference (current-baseline)	Percent Difference
Palo Alto Landfill emissions during the year[2]	9,900	6,451	5,110	9,427	8,617	(1,283)	-13%
Life cycle fugitive emissions[3]	7,953	5,030	5,197	5,389	5,005	(2,948)	-37%
Landfilling recyclable materials[3]	22,779	14,406	14,886	15,435	14,335	(8,444)	-37%

[1] *2005 GHG Emissions are baseline calculations.*

[2] *Code of Federal Regulations (CFR) Title 40, Part 98, Subpart HH model used to calculate greenhouse gas emissions produced by Palo Alto Landfill.*

[3] *EPA WARM model using CalRecycle landfill data used to calculate greenhouse gas emissions produced by handling and disposal of City generated solid waste and includes the capture of recyclables at the Sunnyvale Material Recovery and Transfer Station.*

Challenges:

- The Regional Water Quality Control Plant incinerator beneficially reuses some of the landfill gas. The system is still being optimized to increase the amount of landfill gas the plant can use.
- Product design and packaging development is largely outside of the City's control. The City has implemented a number of internal programs to reduce packaging and waste including the banning polystyrene packaging for City purchases.
- The audience with the most control over waste sorting--janitorial and custodial staff--is very difficult to reach, train, and keep informed of new programs. To address this audience, Staff,

along with Spanish-language support from the City's contract trash hauler GreenWaste of Palo Alto, conducts regular trainings for employees of City facilities.

- In keeping with a City-wide "we go first" strategy, the municipal diversion rate should be equal or higher to the residential and commercial waste streams. Staff is providing training and improved signage to City departments, and has begun internal benchmarking to build awareness and engagement.

Department Name: Office of Sustainability, City Manager's Office

Background: The Office of Sustainability (OOS), established in December 2013, works with other City departments to develop and implement a world class sustainability strategy for Palo Alto that improves quality of life, grows prosperity and builds resilience, while protecting and improving the living systems that sustain us—and leads Palo Alto to recognized as one of the greenest cities in America.

Strategy: In the Office of Sustainability's (OOS) second full year of operation, our priorities are to develop a world class sustainability and climate action plan (S/CAP), integrating the community's highest aspirations and the many initiatives across city departments into coordinated one plan; further embed the City's sustainability commitments into City operations; and develop a city/community wide sustainability performance dashboard, to streamline and improve access to sustainability performance data through the year.

In parallel OOS focused on collaboration and community engagement/input. OOS collaborated with other cities, non-profits, and foundations, bringing resources in to raise awareness and build our capacity to deliver projects focusing on reducing emissions in the two most impactful sectors: transportation and buildings.

Goals:

- develop a world class sustainability and climate action plan (S/CAP), integrating the community's highest aspirations and the many initiatives across city departments into coordinated one plan;
- Integrate sustainability programs and practices into City operations & Community actions, including management systems, procurement, finance and training.
- develop a city/community wide sustainability performance dashboard, to streamline and improve access to sustainability performance data through the year. Foster experimentation, alliances & big leaps, such as electrification, "mobility as a service," "Zero Net" and "Net Positive" Energy building initiatives and smart city.

Initiatives and Activities:

To further these goals, OOS proposes, supports and adds capacity to the sustainability initiatives that other departments are focused on. Here we highlight a few of them.

Sustainability and Climate Action Plan (S/CAP): Working with a world-class consulting team (from DNV-GL and Rocky Mountain Institute) and key city staff, OOS developed a draft sustainability and climate action plan the City's first since 2007), that will once again put Palo Alto in the forefront of sustainability strategy. OOS held a community climate summit (January 2016), including 300 diverse stakeholders from our community, as well as Council and staff, who explored key elements of the 80% by 2030 plan, including roadmaps, strategies and actions in the areas of transportation, energy, and water

Sustainability dashboard: OOS is implementing a sustainability performance dashboard to collect accurate data on key sustainability performance metrics across departments, produce timely reports for management and the public, and provide a fact-based foundation for bold strategic thinking. This platform is designed to reduce staff time on these tasks, improve transparency and auditability, and give Council and city managers actionable and timely data to optimize their activity, inform decisions, and drive performance. The dashboard launch was delayed by unexpected data privacy concerns and unexpected staff attrition, but dashboard now has Utility data loaded, and other data will be loaded this spring.

Mobility as a Service (MaaS): OSS has acted as the "sparkplug" for regional MaaS initiatives, in additional to advancing MaaS discussions within the City. The City Manager hosted the first regional MaaS conversation in City Hall in February, including a delegation from the Finland Ministry of Transportation and Communications (with which we have since signed a Letter of Intent, along with Joint Venture Silicon Valley (JVSV), to collaboration on MaaS development). JVSV has hosted ongoing quarterly convenings, with expanding regional interest.

OSS has advanced various MaaS concepts, including responsive shuttle services, paid parking and parking "cash out" with staff, the TMA, the Comprehensive Plan CAC and community groups. OSS has worked with the Planning Department's transportation group to design MaaS pilots and analysis, including the Shared Use Mobility Center toolkit (interactive map and policy database), Ridescout and VTA employee commuter benefits improvement pilot (app to integrate transit use with commuter benefits), the Commuter Wallet RFP, and a new ride share service called Scoop. In addition OSS held three regional MaaS convenings driving a region-wide strategy with JVSV to transform transportation.

Net Zero Energy: OSS collaborated with the Development Services Department (DSD) to convene a multi-city peer exchange on developing a Zero Net Energy (ZNE) policy, learning from best practices, barriers and opportunities from other cities (including Austin, Cambridge and San Jose). This work was supported by grant from the Urban Sustainability Directors Network's Innovation fund to assist the city in developing California's first Zero Net Energy Policy ahead of the State's adoption cycle. In 2016 the City was invited to New York to collaborate with 13 other leading cities to help drive efficiency and reduce carbon emission from buildings. This seminal work is driving the conversation forward. In collaboration with DSD and other city stakeholders they are proposing an Energy Reach Code in May that leverages this work and attempts to codify greater efficiency in new and retrofitted buildings to inch closer to ZNE.

Electrification: OOS is participating in multi-departmental staff efforts, in response to Council's August 2015 directive, to assess options and develop plans for a citywide electrification strategy. Utilities will launch the first pilot in early 2016: a heat pump electric water heater rebate program. DSD is studying the cost effectiveness and any barriers to entry for Heat Pump technology to encourage greater penetration into existing and new buildings. They are also studying whole house Electrification from a building code perspective.

Electrifying Transportation: Building on Palo Alto's 2014 Electric Vehicle (EV) readiness ordinance developed by DSD, OOS won a $53,000 grant from California Energy Commission to do and education

(outreach to 50 local businesses and two EV "ride and drive events) on the benefits of installing EV Fast Chargers.

OOS also worked with Public Works and BAYCap to secure a $57,500 grant from Bay Area Air Quality Management District to add five new Electric Vehicle Charging Stations (8 ports) to be installed at City Hall – 250 Hamilton Ave; Cowper/Webster parking garage – 520 Webster Street; Cambridge parking garage – 400 Cambridge Ave. (two at this location); Ted Thompson parking garage – 275 Cambridge Ave. (Additional grants for additional charges are pending.) OOS is working with Fleet to implement the City's new EV first policy, and with Public Works and Utilities to review and potentially revise Palo Alto's policies with regard to pricing for use of EV chargers on City facilities.

Compact of Mayors: OOS worked with Mayor Holman to sign Palo Alto onto the global Compact of Mayors--a global cooperative effort among mayors and city officials committed to reducing local greenhouse gas emissions, enhancing resilience to climate change, and tracking progress transparently. The Compact establishes a common platform to capture the impact of cities' collective actions through standardized measurement of emissions and climate risk, and consistent, public reporting of their efforts.

Neighborhood Engagement Pilot: OOS worked with the not-for-profit Empowerment Institute to establish an MOU for the "Cool Blocks" program and develop an initial 10 block pilot of the program. Cool Blocks organizes and trains teams of neighbors, organized by blocks, to select and implement sustainability and resilience actions to reduce household carbon footprints, and create more connected and resilient community.

Finance Scan and Convening: Supported by a grant from Urban Sustainability Directors Network (USDN.org) OOS led a multi-city collaboration exploring how to more effectively fund municipal sustainability initiatives, including a convening bringing together CSOs, CFOs, and Investors to bridge the sustainability targets and financing gap. (Launched early 2016)

Fundraising: OOS has raised $350,000 in grant funding for City sustainability initiatives, including County Alternative Mobility planning; EV education, outreach and charging stations; Multi-City ZNE peer exchange; Sustainability Finance Scan.

Challenges:

OOS is a very small office with a very large mission, and is challenged to fulfill even a part of that mission without permanent staff. OOS relies on coordination with other departments whose resources are also limited and not always available for collaborative activities; we're working to design more effective ways to coordinate sustainability activities across departments. Synchronizing the different times lines and processes of the S/CAP and CompPlan processes has been challenging. The emerging nature of OOS's work requires timely responsiveness (for example in relation to funding and collaboration opportunities and invitations to participate in multi-city platforms and positions) that the City is not always able to provide.

Department: City of Palo Alto Utilities (CPAU)

Background: The mission of CPAU is to earn a high level of customer satisfaction by providing cost competitive, safe, reliable and environmentally sustainable utility services.

Strategy:

- Continue to implement cost effective energy efficiency and water conservation programs
- Implement Local Solar Plan with objective of providing 4% of the community's electrical energy needs from local solar resources by 2023
- Maintain the City's 100% carbon neutral electric supply
- Facilitate adoption of electric vehicles (EVs) in Palo Alto by providing time of use (TOU) electric rate option to residential customers and by optimally utilizing Low Carbon Fuel Standard (LCFS) revenue for the benefit of EV owners in Palo Alto
- Analyze and implement cost-effective electrification (natural gas-to-electric fuel switching) programs
- Concerted effort in CY 2015 and 2016 to engage residential customers to reduce energy use to compete in the Georgetown University Energy Prize
- Encourage participation in the PaloAltoGreen Gas program to offset the carbon emissions associated with natural gas use
- Seek and test emerging technologies that have the potential to enable CPAU to provide more effective utility services
- Consistent with cost of service requirements, provide customer rates that encourage electrification, including greater EV adoption and

Goals:

1. Reduce electric energy use by at least 4.8% by 2023[2] (no GHG impact since electric supply portfolio is carbon neutral)
2. Reduce natural gas use by at least 2.85% by 2023 (4,500 metric tons per year of GHG reduction by 2023)
3. Meet the State's mandated drought-related water savings goals (see figure D-5 for actual reductions). The compliance period is from June 1, 2015 through October 31, 2016.
4. Reduce long-term water use in order to comply with the State's 20% by 2020 per capita water use reduction requirement.
5. Generate at least 4% of electrical energy from local solar by 2023[3] (no GHG impact)
6. Achieve PaloAltoGreen Gas program participation of 20% of natural gas customers by 2020, representing around 10% of the citywide gas usage (16,000 metric tons per year of GHG reduction)
7. Continue to procure long-term renewable electric supplies to maintain carbon neutral electric supplies (no GHG impact since electric supply portfolio carbon neutral)

[2] For electric and gas 10-year energy efficiency goals, see: http://www.cityofpaloalto.org/civicax/filebank/documents/32390

[3] For Local Solar Plan, see: https://www.cityofpaloalto.org/civicax/filebank/documents/39981

Initiatives and Activities:

Top Sustainability Initiatives in 2015

Sustainability Initiative	Objective	Outcome
Electricity and Natural Gas Efficiency and Conservation Programs	Promote resource efficiency to commercial and residential customers for cost savings, lowered consumption, and avoided greenhouse gas emissions.	See impact of energy efficiency programs on utility loads in Figures D-2 and D-3. Due to the relatively warm winter of 2015 and water conservation, the natural gas usage declined by close to 15% in 2015
Renewable Portfolio Standard (RPS) eligible electric supplies	Increase renewable energy in CPAU's electric portfolio	The City's RPS was 20.6% in 2013, 23.3% in 2014, and 26.0% in 2015. Executed contracts will result in RPS of 42.9% in 2016, and 57.5% in 2017.
Local Solar Program	Increase local solar generation from 0.7% of total load to 4.0% by 2023.	Solar group-buy discount program, Peninsula SunShares, implemented in 2015, resulted in 236 kW of new local solar. The first two Palo Alto CLEAN program applications expected to result in a total of 1.4 MW of new solar installed in 2016. New Community Solar and Solar Donation programs are under design.
PaloAltoGreen Gas	Enroll 20% of all natural gas customers in a voluntary carbon offset program by 2020, equivalent to 10% of total natural gas usage[4].	Participation was about 2% of citywide gas usage in 2015 and is expected to double in 2016. The program is on track to reach the goal of 10% of load participation by 2020.
Facilitate Electrification	Facilitate electrification of natural gas appliances and adoption of electric vehicles	Pilot program to facilitate installation of heat-pump water heaters to commence in January 2016. EV count is Palo Alto about 1,200 at the end of 2015.

[4] The City of Palo Alto facilities began participation in the PaloAltoGreen Gas program for 100% of their usage starting in July 2015. That usage accounts for a vast majority of the program participation for 2015; the City-owned facilities natural gas use, and corresponding participation in the program, will decline considerably when the incinerator at the water quality control plant is retired in the 2017-18 timeline.

Resource Efficiency and Local Renewable Energy Programs

Resource	FY 2015 Savings Goals (% of load)	FY 2015 Savings Achieved (% of load)	FY 2015 Savings Achieved
Electricity	0.60%	0.77%	7,192 MWh
Gas	0.50%	1.20%	225,080 therms
Water	0.91%	1.54%	68,227 CCF
Customer-side Renewable	**Program Goal**	**FY 2015 Achievement**	**Cumulative Achievement**
Solar Electric (PV)	6,500 kW by 2017	814 kW	5,877 kW since 1999
Solar Water Heating	30 systems/year	15 systems	58 systems since 2008

For more details on individual efficiency and local renewable programs and achievements, please review report linked below: http://www.cityofpaloalto.org/civicax/filebank/documents/14820

Data:

1. See impact of energy efficiency programs on utility loads in Figures D-2 and D-3.
2. See RPS increase since 2005 in Figure D-1.

Challenges:

1. Current building standards (Title 24) adopted by the California Energy Commission discourage the adoption of electric water heating and space heating, despite the higher efficiency performance of heat pump appliances. CPAU plans to engage with CEC as well as other stakeholders to remove this bias.
2. For residential customers, **switching from natural gas using appliances (for space heating, water heating and cooking) to electric appliances requires a high upfront investment and is not cost effective**, especially if the home's electrical panel needs to be upgraded and the upgrade costs are applied to that single improvement .
3. **Future State emergency water reduction regulations are unknown**.
4. Hydroelectric power as well as potable **water supplies could be at risk in potentially disruptive climate change scenarios**.
5. Disruptive innovation in local PV generation, distributed energy storage (including rolling storage provided by growing EV fleets) and net zero buildings may require **re-examination of CPAU business models.**
6. Cost of service based retail rate making process required by State law may **limit the options available to encourage electrification through retail rate structures.**
7. While CPAU is delivering efficiency gains generally ahead of targets, greater progress will be needed to achieve California's 80% by 2050 GHG reduction goals, or potentially more aggressive S/CAP goals. **"Low hanging fruit" efficiency have been achieved,** so deeper gains may require new approaches.
8. Electrification will increase electricity demand and reduce natural gas revenues introducing the **challenge of maintaining natural gas system integrity** if natural gas use and revenues decline dramatically in the coming decades.

Supplemental Graphs:

Figure D-1: Electricity Portfolio: 2005-2025 (Actuals and Projections)

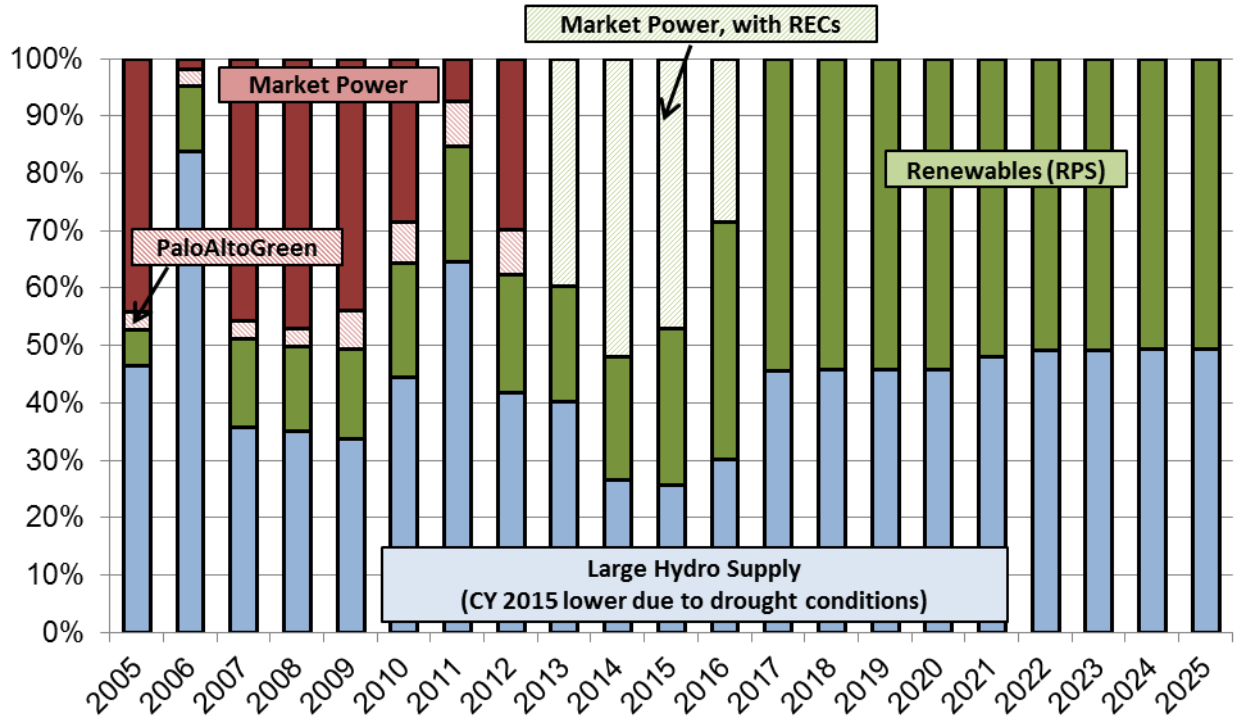
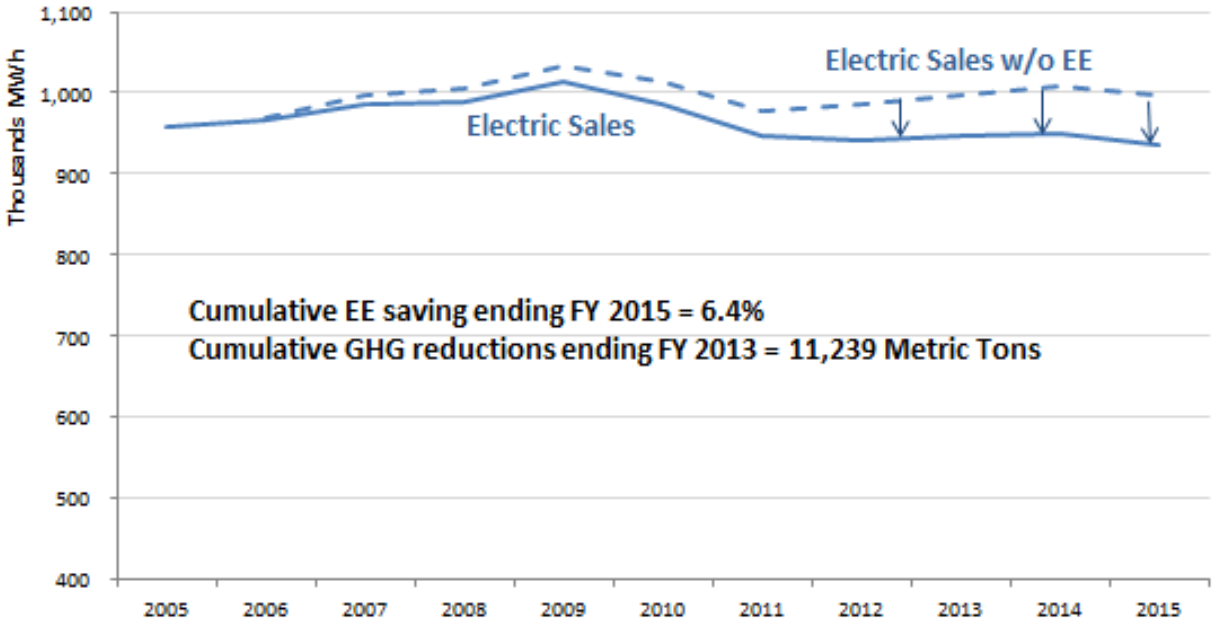


Figure D-2: Impact of Energy Efficiency Programs on Electric Sales[5]



[5] There are no GHG reductions from electric energy efficiency after 2013 since electric supplies are carbon neutral.

Figure D-3: Impact of Energy Efficiency on Gas Sales

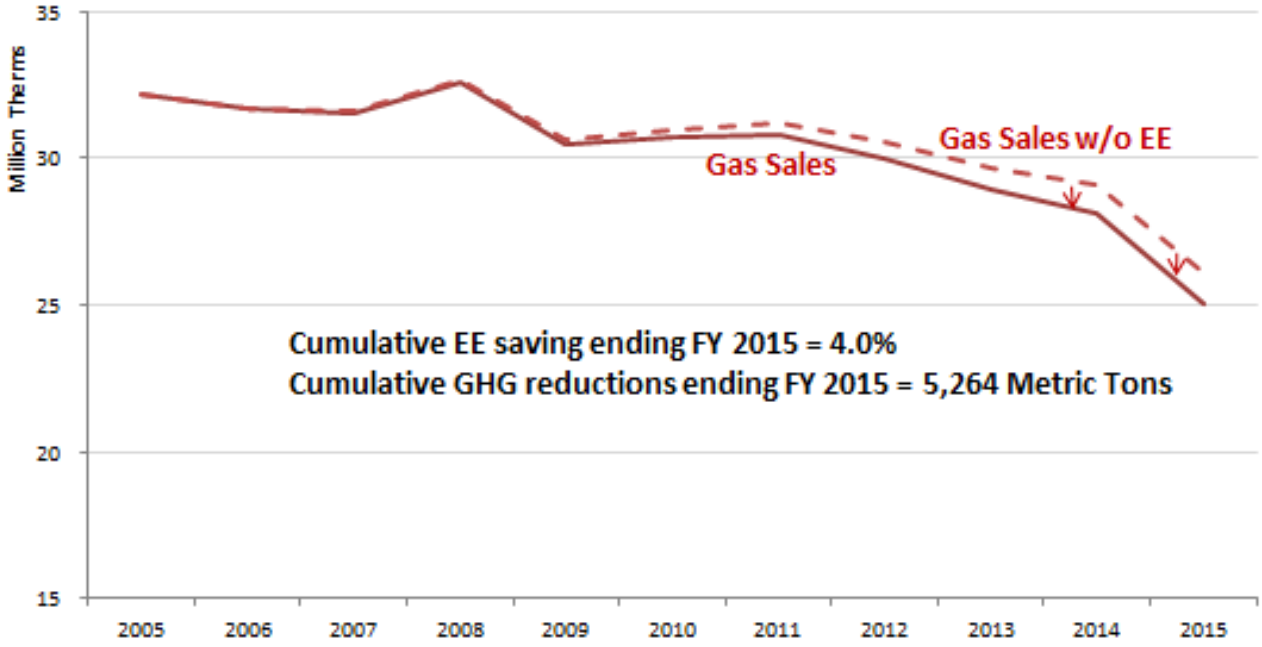


Figure D-4: Residential Per Capita Utility Consumption Declining

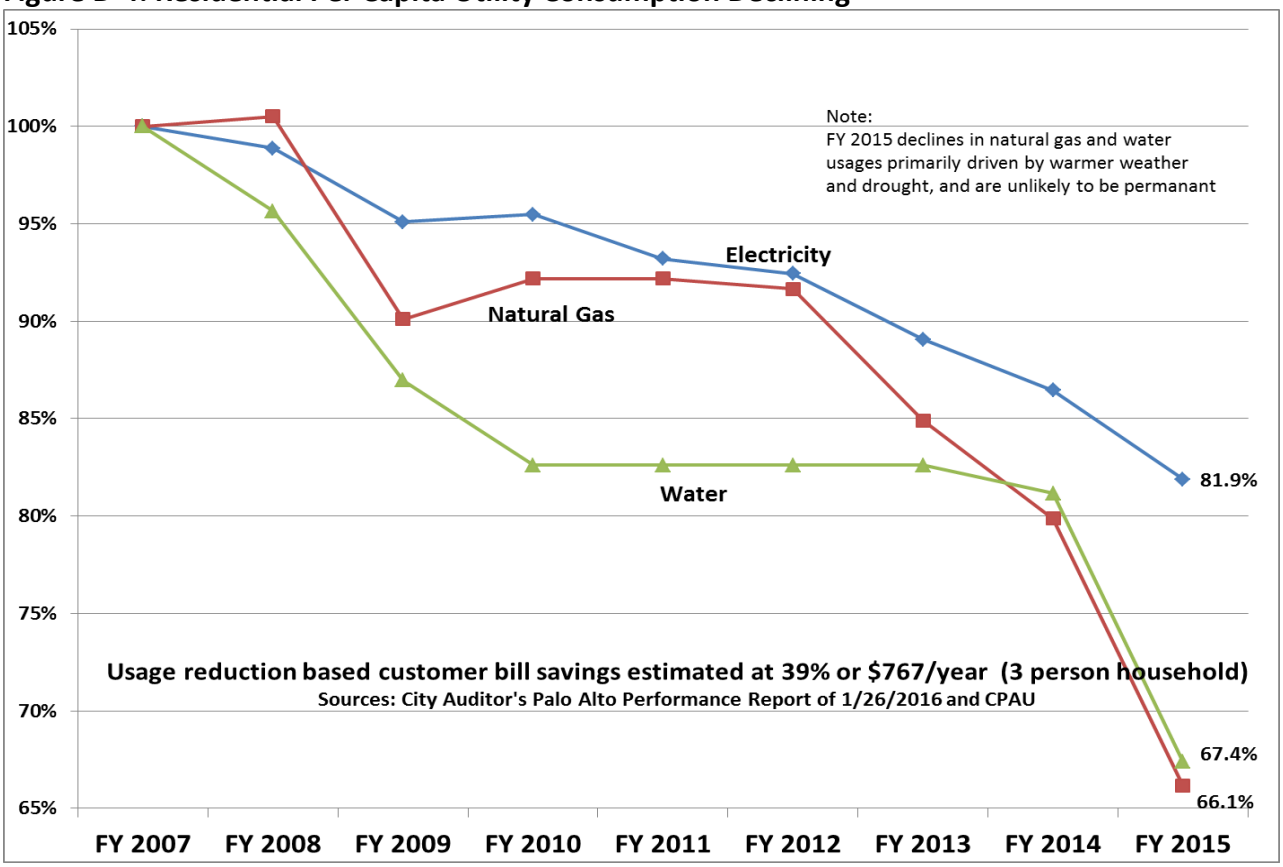


Figure D-5: Progress in Meeting the State-mandated 24% Potable Water Use Reduction Target