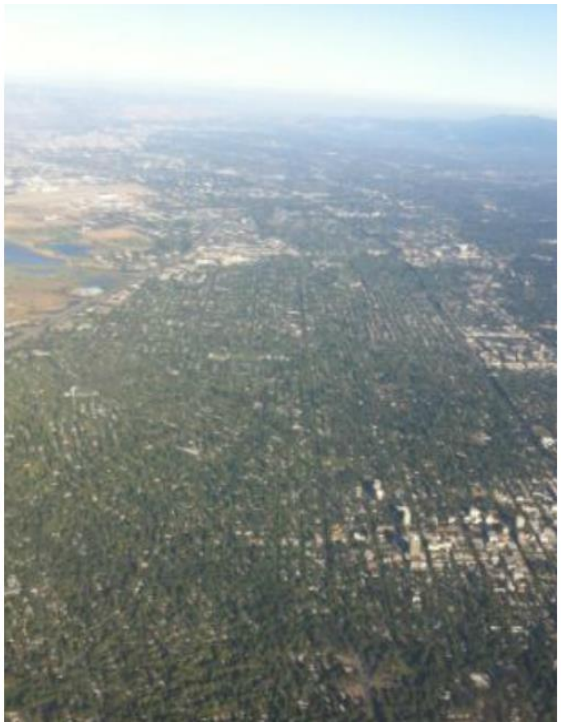
Growing the Tree Canopy in South Palo Alto: Goals and Strategies




Submitted to: City of Palo Alto, California

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CANOPY
20 YEARS

Front cover photo credit (center): Matt Ritter

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Thanks also to community members Susan Rosenberg and Annette Glanckopf, and the 500 respondents to the survey, for providing your thoughts and opinions about Palo Alto's trees.

1.0 Introduction

Providing all people with equal access to the benefits of trees within municipalities is a widespread challenge. Trees are a crucial resource, especially in urban areas, and the environmental and economic constraints to planting more trees can only be overcome with planning, investment, and engaging the community. Cities that prioritize tree canopy equity take a critical step toward devising solutions to grow healthy trees and healthy communities.

In 2011, as part of the Palo Alto Urban Forest Master Plan (UFMP), a canopy cover analysis was conducted by Dr. Qingfu Xiao of UC Davis (the UC Davis Report, for short.) The report identified that north Palo Alto has approximately 22% more tree canopy than south Palo Alto. For Palo Alto's 17 predominantly residential neighborhoods, north Palo Alto had 11% more tree canopy cover than south Palo Alto in 1982, and in less than thirty years the disparity has doubled. Community feedback confirmed that this is an important issue and addressing it was earmarked as one of the Year One implementation priorities of the UFMP.

The purpose of this study is to identify the reasons for less tree canopy in south Palo Alto and develop strategies to reverse the trend of decreasing canopy in the impacted areas. We recommend that: 1. The City adopt an ambitious but realistic tree canopy cover goal for South Palo Alto; 2. The City partner with Canopy to launch a campaign to plant more public and private trees and engage the community in south Palo Alto; 3. The City work with internal and external partners to prevent canopy loss through innovative urban forest management strategies.

The benefit of this analysis is that the recommended tree canopy cover goals and strategies are strongly supported by research and have made reasonable assumptions. The canopy assessment and calculations are reinforced by community feedback, which indicated desire for more trees and willingness to care for them. The goals are ambitious and carefully crafted for the City of Palo Alto to achieve and even surpass in a logical time frame.

10 residential neighborhoods of North Palo Alto		1982	2010
1	College Terrace	39.9	41.6
2	Southgate	36.4	45
3	Community Center	44.3	51.1
4	Duveneck/ St Francis	45.5	51.3
5	Crescent Park	49.4	55.1
6	University South	34.8	38.6
7	Professorville	49.6	53.4
8	Leland Manor/ Garland	45.2	47.5
9	Old Palo Alto	54.2	55.8
10	Downtown North	29	38.7
	Average	**42.83**	**47.81**

7 residential neighborhoods of South Palo Alto		1982	2010
1	Green Acres	35.1	39.9
2	Midtown/ Midtown West	36.9	38.6
3	Barron Park	44.9	46.5
4	Palo Verde	37.3	37.7
5	Greenmeadow	35.5	35.3
6	Fairmeadow	41.5	38.9
7	Charleston Meadows	37.7	36.9
	Average	**38.41**	**39.11**

Figure 1. North Palo Alto and south Palo Alto percent canopy cover comparisons by neighborhood (UFMP).

Tree Canopy Cover %	1982	2010	Growth Rate
North Palo Alto	43	48	11.6
South Palo Alto	38	39	1.8
Difference	**11.5**	**22**	**6.5 x**

Table 1. Percent tree canopy cover for north Palo Alto and south Palo Alto in 1982 and 2010, and the difference over that time period.

Figure 2. Urban Forest Master Plan survey responses elevated south Palo Alto's need for more trees, one of the UFMP's "Hot Topics."

2.0 Extent of the Tree Canopy Disparity

We believe our recommendations are viable because they stem from a further analysis of the of the UC Davis Report placed it in the historical context of Palo Alto's urbanization, our calculation methods were validated by urban forestry experts and program feasibility tested against the south Palo Alto community feedback.

2.1 The UC Davis Report's Findings

The Palo Alto Urban Forest Master Plan, adopted by City Council on May 11, 2015, sets an overarching goal for "a well-developed citywide urban forest." Year One implementation includes numerous goals, policies, and programs that strive for innovation and positive environmental changes. In 2011, the UFMP team invested in a citywide neighborhood canopy analysis, the UC Davis Report, comparing tree canopy cover in 1982 to that of 2010. The goal of the in-depth comparison was to identify trends in the last 30 years and establish existing conditions for future monitoring. The UC Davis Report confirmed and quantified the canopy disparity and the decreased tree canopy cover (TCC) in south Palo Alto already acutely perceived by the community and observed by successive city arborists, as evidenced in the following maps and tables:

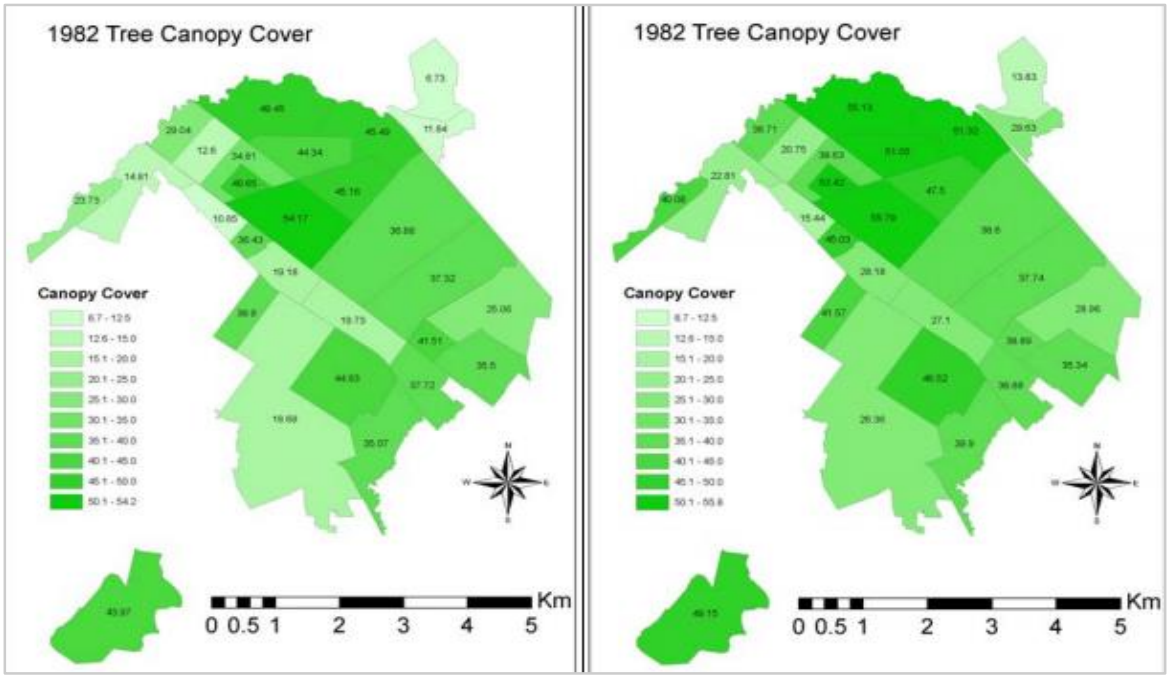


Figure 3. Maps of the average Palo Alto TCC in 1982 and 2010 mapping units (UC Davis Report).

Dr. Qingfu Xiao used NAIP (National Agriculture Imagery Program) aerial imagery and GIS (Geographic Information Systems) to identify and map land use and TCC. The study area included 28 mapping units with boundaries created from GIS layers, and data layers were created to show and quantify land cover types. The five land cover types include tree/shrub, irrigated grass, impervious, bare soil/dry vegetation, and water. These were grouped as Tree (tree/shrub), Pervious (grass/bare soil/dry vegetation), and Impervious (impervious/water) (Table 2). The average TCC percentages in the predominantly residential neighborhoods in south Palo Alto (Table 3) were not as high as those in north Palo Alto neighborhoods, and some south Palo Alto neighborhoods even experienced decreased TCC.

Neighborhood		1982			2010			% Change		
	Total area (m^2)	T	I	P	T	I	P	T	I	P
Green Acres	1250006	35.1	49.3	15.6	39.9	44.6	15.5	13.8	-9.5	-1
Midtown/Midtown West	3124665	36.9	54.2	8.9	38.6	50.9	10.5	4.7	-6.1	17.9
Charleston Terrace	1601166	25.1	64.3	10.7	29	57.8	13.3	15.6	-10.1	24.5
Barron Park	1569509	44.9	45.1	9.9	46.5	42.4	11.1	3.5	-6.2	12
Palo Verde	2038634	37.3	56.6	6.1	37.7	51.5	10.7	1.1	-9	77.3
Greenmeadow	1032520	35.5	54.8	9.7	35.3	52.6	12.1	-0.4	-4.1	24.8
Charleston Meadows	800660	37.7	55.8	6.4	36.9	53	10.1	-2.2	-5.1	57.1
Fairmeadow	276802	41.5	53.4	5.1	38.9	51.6	9.5	-6.3	-3.3	85.6
Ventura	866900	19.7	72.8	7.5	27.1	63.7	9.2	37.3	-12.5	22.8

Table 2. T: Tree (%), I: Impervious (%), and P: Pervious (%) in 1982, 2010, and percent change.

South Palo Alto Neighborhood	Average TCC 1982 %	Average TCC 2010 %	Net TCC Difference %
Green Acres	35.1	39.9	14%
Midtown/Midtown West	36.9	38.6	5%
Charleston Terrace	25.1	29.0	16%
Barron Park	44.9	46.5	4%
Palo Verde	37.3	37.7	1%
Greenmeadow	35.5	35.3	-1%
Charleston Meadows	37.7	36.9	-2%
Fairmeadow	41.5	38.9	-6%
Ventura	19.7	27.1	38%
Average	34.9	36.7	7%

Table 3. South Palo Alto Neighborhood tree canopy cover (TCC) in 1982, 2010, and the change over that time period.

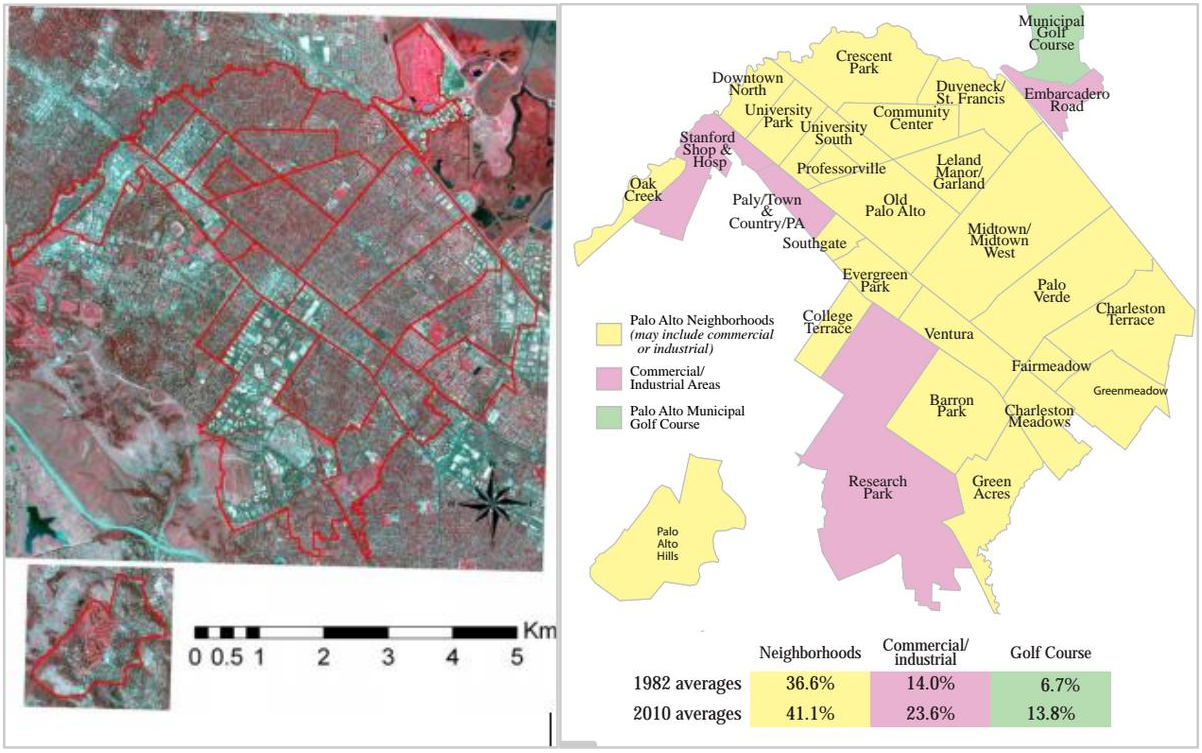


Figure 4. 2010 NAIP (near infrared, red, and green photo) image (left); and Palo Alto's 28 mapping units: neighborhoods, commercial/industrial lands, and municipal golf course (right) (UC Davis Report).

2.2 Historical Context and Impact of Development on Trees

The tree canopy disparity arose from a combination of factors over the last century of tree planting and development in Palo Alto.

The City of Palo Alto experienced identifiable waves of tree planting since its establishment over 100 years ago. The development trends, resident views, preferred species, and management plans that governed tree planting and removal differed between time periods, weaving together the unique tapestry of trees that Palo Alto enjoys today. Four distinct periods formed the urban forest that stands today: the years of 1890-1920, 1920-1950, 1950-1980, and 1990-present.

Residents were the primary agents to bringing new species to Palo Alto during early tree plantings from 1890 to 1920. Senator Stanford and residents moving from the East and Midwest U.S. imported many non-native tree species, thereby increasing plant diversity with new street and yard plantings. From 1920 to 1950 a street tree system was established and numerous park improvements were made. By the 1950s city staff conducted some crucial analyses and made decisions that forever changed street tree management practices in Palo Alto.

In particular, between 1950 and 1980, a preferred species list was created. Since the city had not limited residents' species choices in earlier years, there was serious need for change in management strategy. Of the 96 species planted, only 7 were deemed good street trees, and eventually 30 made the list for planting. The first *Palo Alto Street Tree Management Plan* was created in 1982, in order to address concerns about the need for diversity of tree species and ages.

From 1990 to present, Palo Alto has made great strides in urban forestry through the creation of a Tree Ordinance, founding of Canopy, and numerous management documents and programs. Canopy was established in 1996 to be a resource to the community on tree-related matters, and has worked with city staff and residents to contribute to the tree-related goals stated in documents such as the *Comprehensive Plan,* the *Tree Technical Manual* published in 1998, the *Palo Alto Urban Forest Master Plan* adopted in May 2015.

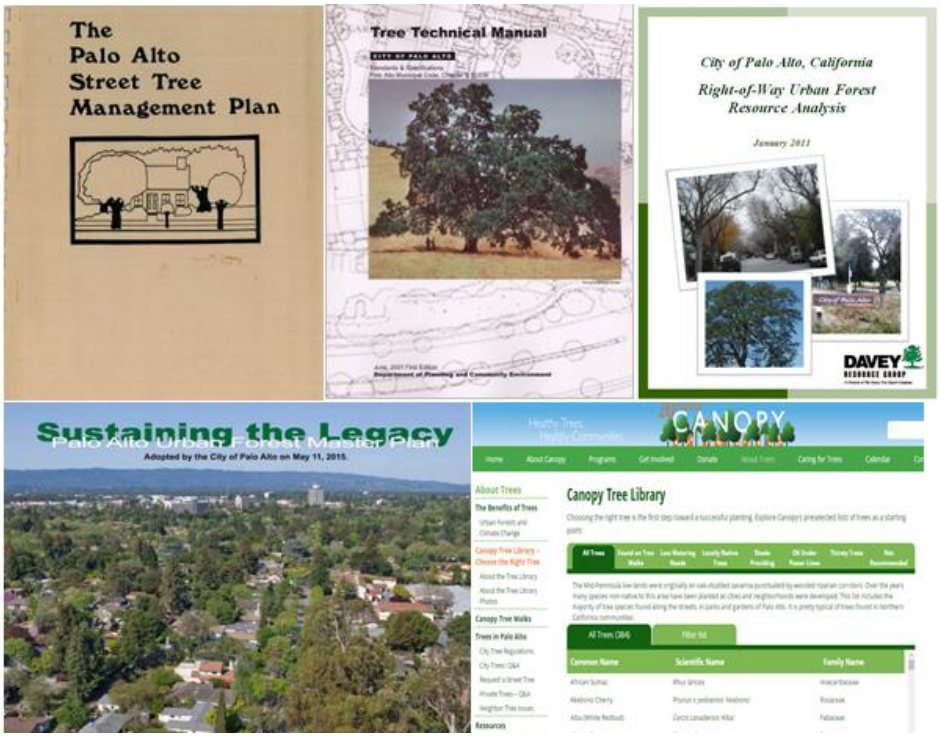


Figure 5. Some influential management plans and resources for use by Palo Alto.

Development and construction were the most significant forces that resulted in the increased canopy disparity between north and south Palo Alto. Many of the north Palo Alto residential neighborhoods had large older homes on big lots and narrow streets. The large lots provided space for large trees, many which were planted in the late 19th and early 20th centuries. These trees have had a hundred years to grow and now form a lush canopy over entire streets. This head start, with ample growing space, long-lived species, and minimal soil compaction has resulted in a beautiful lasting canopy in the north.

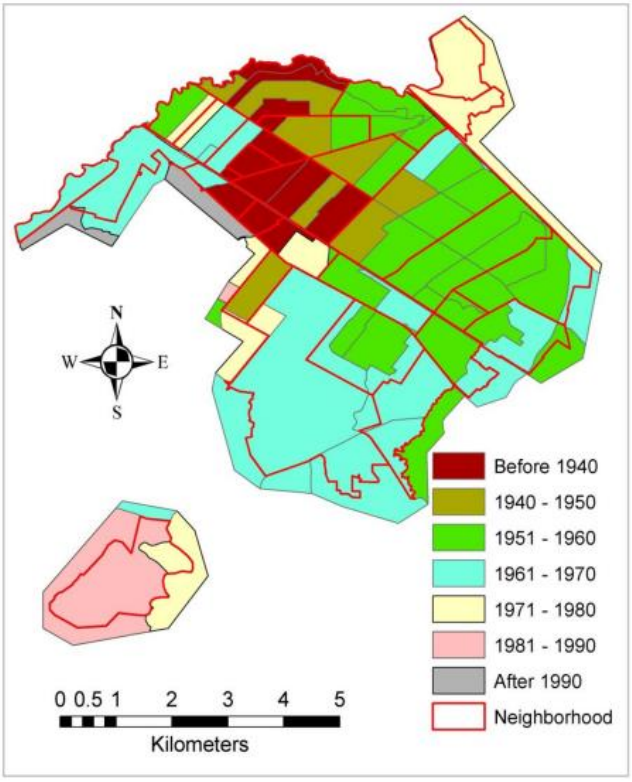


Figure 6. Median year structure built for census block groups categorized by decade of construction (UC Davis Report).

In the 1950s, many south Palo Alto neighborhoods experienced a boom in development that included different priorities and construction techniques from those in north Palo Alto years earlier. The conversion of large rural lots into structured subdivisions was an American hallmark of post-World War II development. Fairmeadow and Greenmeadow neighborhoods received new infrastructure featuring wider roads, monolithic sidewalks, and the iconic Eichler houses. This housing boom yielded a push for fast-growing trees, which were often inferior and short-lived species. From the 1950s to 1980s, the 30 approved street tree species were planted repeatedly throughout south Palo Alto - 60,000 of them.

South Palo Alto experienced a “perfect storm” from the 1950s to 1990s in terms of development trends yielding today’s diminished canopy. Rather than having a street tree in a planter strip and yard trees behind the sidewalk, many of the new south Palo Alto neighborhoods were designed with monolithic sidewalks (rolled curbs) and many lots featured a single yard tree. The lot-by-lot development with low-impact tools was a thing of the past, as south Palo Alto experienced fast, widespread changes with earthmoving equipment and soil compaction.

In addition, there was no Tree Ordinance in place, so tree preservation and protection were not required before or after construction. Power lines were placed in the back of the property so as

not to be seen from the picturesque frontage. The nutrient deficient clayey soils, compaction and from contractor machinery, often led to premature tree mortality at these new homes. Many of the trees that did survive were subsequently removed by residents and the City so as not to interfere with the underground utilities in the front yard or overhead power lines in the back yard. Radiant heating in the floors even precluded planting trees in the side yard setbacks. Meanwhile, the tree canopy cover in the north was steadily increasing, making the gap that much more noticeable.

Overall, some of the major factors that contributed to the disparity include:

Influencing factors	Resulting impacts
Short-lived and inferior species were planted in south Palo Alto.	Premature removal of landscape and street trees with no required replacements.
Conflict between tree roots and underground pipes used for radiant heating.	
South Palo Alto homes tend to be single story, which tend to cover more land and are subject to less discretionary development review.	Less space for private trees and lower chance of incorporating designated trees.
The predominant soil type in south Palo Alto is Basin, in contrast to north Palo Alto neighborhoods that benefit from more fertile alluvial deposits.	High clay content and poor drainage do not provide optimal site conditions for tree growth.
Many south Palo Alto neighborhood rights-of-way have no planting strips.	Trees in yards are less likely to join canopies over the street and make the canopy *seem* less dense than it actually is.

From the 1990s to present day, Palo Alto has experienced another transition in the form of land redevelopment. The real estate boom today has prioritized re-use of land and in-fill development, and is causing a reduction in many landscaped areas. Some larger redevelopments have resulted in new multi-family residences with less landscaped area, while single family residences are being remodeled or being built anew with an expanded footprint. Many residents with new homes are opting for less landscaping due to cultural preferences and lack of planting space due to the larger building footprint.

The City strives to regulate development activities through project review, mitigation, inspection, enforcement, and outreach. The Tree Ordinance prohibits removal of protected and street trees without authorization, while the Urban Forest Master Plan recently instituted a policy for no net loss of canopy throughout the city. City Urban Forestry staff note that this parcel by parcel change

through development review has resulted in more trees planted per lot in south Palo Alto today than in the past, but is a slow change that requires staff oversight.

Increasing tree canopy in south Palo Alto requires solutions that can overcome the many historical issues that have prevented tree planting over the last fifty years. Many problems persist: houses still have radiant heating, house footprints are expanding, basement light wells extend into side yard setbacks, the clayey soil results in surface rooting no matter what species is planted, and so on. The 2010 Davey Resource Group inventory found that 92.5% of viable planting sites in the right-of-way are already filled, meaning that there is limited opportunity for increasing the number of street trees. The question remains: "how do we increase canopy in an area with so many obstacles?"

2.3 Other Influential Research Findings

2.3.1 Urban Forestry Science and Practice

We interviewed experts in urban forestry and arboriculture research and practice, and gathered valuable information about growing the urban tree canopy. Through conversations with Dr. Greg McPherson and Dr. Lara Roman of the US Forest Service, we identified the most important needs for data collection and evaluation of Palo Alto's TCC. McPherson offered formulas to determine the canopy cover goals and how they can be translated into estimated numbers of trees to be planted. Roman explained how to plan for tree mortality adequately when calculating time and resources needed for planting plans, and discussed the benefits of emerging programs like Open Tree Map.

Alice Ewen of the US Forest Service shared some successful efforts employed by other cities to increase TCC, including tree planting programs with nonprofit groups, tree sales, and various incentive programs. She shared that "treebates" (rebates for planting trees) are a popular incentive program (like Palo Alto's Right Tree Right Place program), but require a dedicated source of funding to sustain and are primarily supplemental. Ewen emphasized the importance of focusing on providing valuable services when crafting incentives, a sentiment shared by Rachel Malarich (Treepeople) when discussing community-based social marketing strategies.

At a recent National Research Council workshop, US Forest Service researcher Morgan Grove discussed the future of urban forestry programs and the shifts toward sustainability. The science of mapping, calculating quantifiable benefits, and goal-setting for Urban Tree Canopy (UTC) has improved significantly in recent years. UTC prioritization is described as an effort to increase tree ecosystem services and benefits on all lands. The three P's of Prioritization discussed with Michael Galvin, who has conducted UTC assessments for other cities, are critical to establish:

1) Possible - where is it biophysically *feasible* to plant trees?
2) Preferable - where is it socially *desirable* to plant trees?
3) Potential - where is it economically *likely* to plant trees?

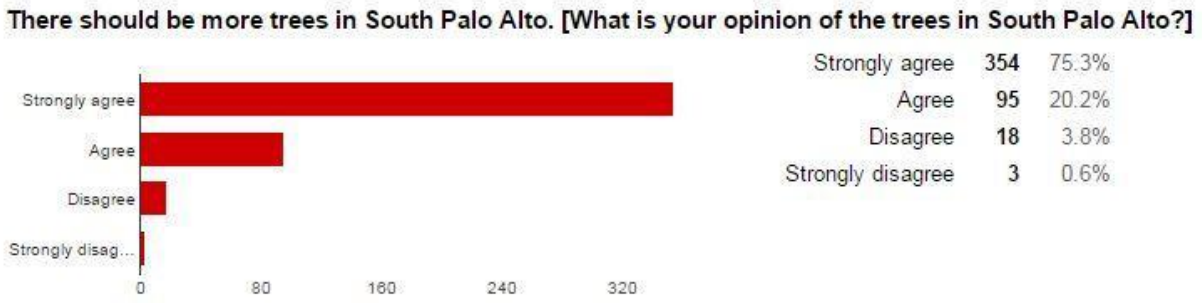
Prioritizing with Geographic Information Systems (GIS) requires review at the neighborhood and individual parcel levels. With this information, evaluation of the Forest Opportunity Spectrum (residential, industrial, public right-of-way, large parks, forest patches, stream valleys, water, etc.) can help identify stakeholders and potential for new tree sites. Planting in the public right-of-way alone is not sufficient to achieve the typical tree planting campaign goals, which require working with private residential "new forest landowners."

2.3.2 South Palo Alto Tree Canopy Community Survey

An important element of our analysis involved reaching out to south Palo Alto residents. We created the south Palo Alto Tree Canopy Community Survey which was made available online from November 20, 2015 to December 21, 2015. The purpose of the survey was to collect south Palo Alto individual residents' opinions about street and yard trees. The goals were to gather quantitative and qualitative data about south Palo Alto residents' preferences and to open channels of communication for future community input. The quantity (500) and quality of responses surpassed expectations and informed our recommendations.

More than **95%** of respondents strongly agree or agree that ***there should be more trees in south Palo Alto.***

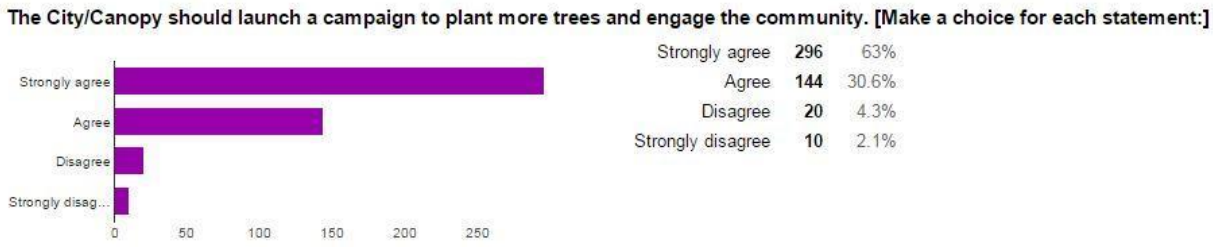
> *"On my street years ago, the city planted Shamel Ashes which were a huge tree uprooting everything and tangling the utility wires. The city has removed them, one by one. If the city offered my street/neighborhood to replant city trees, I think the neighbors would love it. We need the correct tree for a neighborhood street."*
>
> *- Adobe Meadow resident, 11/22/2015*



93% of respondents strongly agree or agree that the ***City/Canopy should launch a campaign to plant more trees and engage the community.***

"In the past I have worked with Canopy to plant more trees on our street and would be willing to do it again. I live on Matadero Ave. I'd like to see both Canopy and the City work together for better street tree pruning. I have had both good and bad luck in the past with pruning of City owned trees."

- Barron Park resident, 11/21/2015

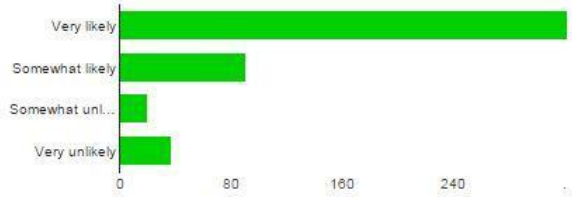


Nearly **70%** of respondents indicated that they would *"very likely"* ***water and take care of a new street or yard tree if one was provided.***

"In addition to adding beauty to our surroundings, trees are vitally important to air quality, they provide shade for our homes, resulting in energy savings, and they provide homes for local wildlife. They are well worth any additional water requirements."

- Barron Park resident, 11/21/2015

Would you water and take care of a new street or yard tree if one was provided to you? [Make a choice for each statement:]

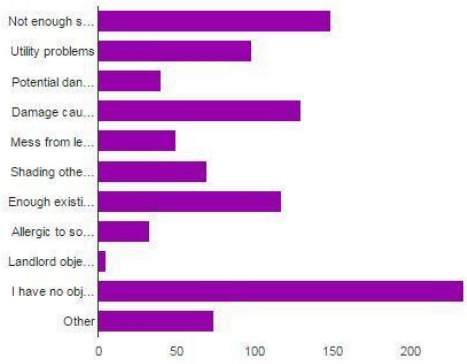


Very likely	322	68.5%
Somewhat likely	91	19.4%
Somewhat unlikely	20	4.3%
Very unlikely	37	7.9%

When asked to identify issues that could prevent tree planting on their property, nearly **50%** of respondents indicated that they have ***no objections to planting more trees***.

> *"Can the city recommend drought tolerant trees? I would be happy to plant those."*
>
> *- Palo Verde resident, 11/30/2015*

We would like to know what prevents people from planting trees on their property. Identify the issue(s) that could prevent tree planting on your property:



Not enough space	149	31.7%
Utility problems	98	20.9%
Potential danger from falling branches	40	8.5%
Damage caused by tree roots	130	27.7%
Mess from leaves or fruit	50	10.6%
Shading other plants too much	70	14.9%
Enough existing trees	117	24.9%
Allergic to some trees	33	7%
Landlord objects to new trees	5	1.1%
I have no objections to planting more trees	234	49.8%
Other	74	15.7%

3.0 Recommendations

Our understanding of the extent of the canopy disparity reported in the UC Davis Report, the history of tree planting and development, and the community's aspirations, provides a solid basis for our recommendations to grow the tree canopy in south Palo Alto.

We recommend canopy cover goals and strategies that are innovative and attainable, requiring investment of time and efforts from many community partnerships. The City, non-governmental organizations, private businesses, and residents all have a part to play to increase tree planting and care in order to grow the tree canopy in south Palo Alto. An integrated management approach will combine education, communication, incentives, and regulations to guide the recommended goals and strategies.

We analyzed land cover types in Palo Alto to determine the potential for increasing tree canopy cover, and to propose draft canopy goals for each neighborhood in south Palo Alto. Each neighborhood goal includes a tree canopy cover rate increase, the approximate number of shade trees to be planted, and how long it will take to reach our goals. Tree canopy cover (TCC) is the percentage of a site covered by the canopies of trees, and is a popular metric used to maintain and improve forest cover.

Achieving the canopy goals requires direction and planning. The November 2015 South Palo Alto Tree Canopy Community Survey brought to light opportunities to increase the overall tree canopy cover in south Palo Alto through 1) A campaign to plant more trees and 2) Measures to prevent canopy loss in south Palo Alto. This direction will guide efforts for program planning and collaboration with stakeholders for years to come.

3.1 An achievable tree canopy cover goal for south Palo Alto: Increase TCC by 8% over 10 years

Based on the 2010 data, south Palo Alto's TCC is approximately 37%, a total coverage of 4,670,127 square meters. South Palo Alto's percentage of Vegetated Possible TCC, grass or shrub (pervious) area that is theoretically available for the establishment of trees, was halved in order to represent available planting area conservatively. Planting trees in this newly calculated Vegetated Possible TCC area would increase tree canopy by 719,499 square meters, for an overall increase of 15%. If achieved, south Palo Alto's TCC will then be 43% (5,389,626 square meters). If the average tree canopy of newly planted trees reaches 20-foot diameter crown spread, we would need to plant about 20,000 trees to reach this lofty goal.

South Palo Alto Neighborhood	Average TCC 2010 %	Pervious area %	Vegetated Possible TCC (m^2)	Vegetated Possible TCC halved (m^2)	Number of Trees	TCC after new tree planting %	TCC increase after new tree planting %
Green Acres	39.9	15.5	193,751	96,875	3,229	48	19
Midtown/Midtown West	38.6	10.5	328,090	164,045	5,468	44	14
Charleston Terrace	29.0	13.3	212,955	106,478	3,549	36	23
Barron Park	46.5	11.1	174,215	87,108	2,904	52	12
Palo Verde	37.7	10.7	218,134	109,067	3,636	43	14
Greenmeadow	35.3	12.1	124,935	62,467	2,082	41	17
Charleston Meadows	36.9	10.1	80,867	40,433	1,348	42	14
Fairmeadow	38.9	9.5	26,296	13,148	438	44	12
Ventura	27.1	9.2	79,755	39,877	1,329	32	17
Total	36.7		1,438,998	719,499	23,983	43	15

Table 4. Calculated TCC goals for each south Palo Alto neighborhood to reach an overall increase of 15% TCC.

A more conservative goal is to aim for an increase of 359,750 square meters (calculated as one quarter of the Vegetated Possible TCC rather than one half), growing the canopy by about 8% for an overall TCC of 40%. This goal may be achieved with the addition of approximately 10,000 trees, which may suit the needs and resources of Palo Altans as a starting point. There are nearly 10,000 parcels in south Palo Alto, with a significant number of property parcels and good distribution of parks, schools, and vacant street tree sites throughout each neighborhood.

One of the most encouraging parts of a plan to plant 10,000 trees is the potential to plant new trees on many properties without burdening homes with too many new trees to maintain. Fifty percent of survey respondents indicated that they have no objections to planting more trees on their property, which is an indicator that at least 5,000 new trees would be well-received on single family residences. Coincidentally, the difference in the number of parcels and trees to plant (about 2,000) is just over the number of vacant street tree sites that need to be filled, making it that much more attainable to close the gap and get 10,000 new trees in the ground. The task of persuading property owners to plant numerous new trees on their property would be daunting, but planting just one tree per property is a goal that Palo Alto can certainly accomplish.

South Palo Alto Neighborhood	Average TCC 2010 %	Vegetated Possible TCC (m^2)	Vegetated Possible TCC (1/4)(m^2)	Number of Trees	TCC after new tree planting %	TCC increase after new tree planting %
Green Acres	39.9	193,751	48,438	1,615	44	10
Midtown/Midtown West	38.6	328,090	82,023	2,734	41	7
Charleston Terrace	29.0	212,955	53,239	1,775	32	11
Barron Park	46.5	174,215	43,554	1,452	49	6
Palo Verde	37.7	218,134	54,534	1,818	40	7
Greenmeadow	35.3	124,935	31,234	1,041	38	9
Charleston Meadows	36.9	80,867	20,217	674	39	7
Fairmeadow	38.9	26,296	6,574	219	41	6
Ventura	27.1	79,755	19,939	665	29	8
Total	36.7	1,438,998	359,750	11,992	40	8

Table 5. Calculated TCC goals for Palo Alto neighborhoods to reach an overall increase of 8% TCC.

South Palo Alto Neighborhood	Number of Parcels	Number of Trees to Plant to Reach TCC Increase of 15%	Number of Trees to Plant to Reach TCC Increase of 8%
Green Acres	363	3,229	1,615
Midtown/Midtown West	4,072	5,468	2,734
Charleston Terrace	628	3,549	1,775
Barron Park	1,437	2,904	1,452
Palo Verde	1,019	3,636	1,818
Greenmeadow	437	2,082	1,041
Charleston Meadows	941	1,348	674
Fairmeadow	301	438	219
Ventura	635	1329	665
Total	9,833	23,983	11,993

Table 6. Overview of the number of parcels (air parcels and property parcels), and the number of trees required to reach 15% TCC increase and 8% TCC increase.

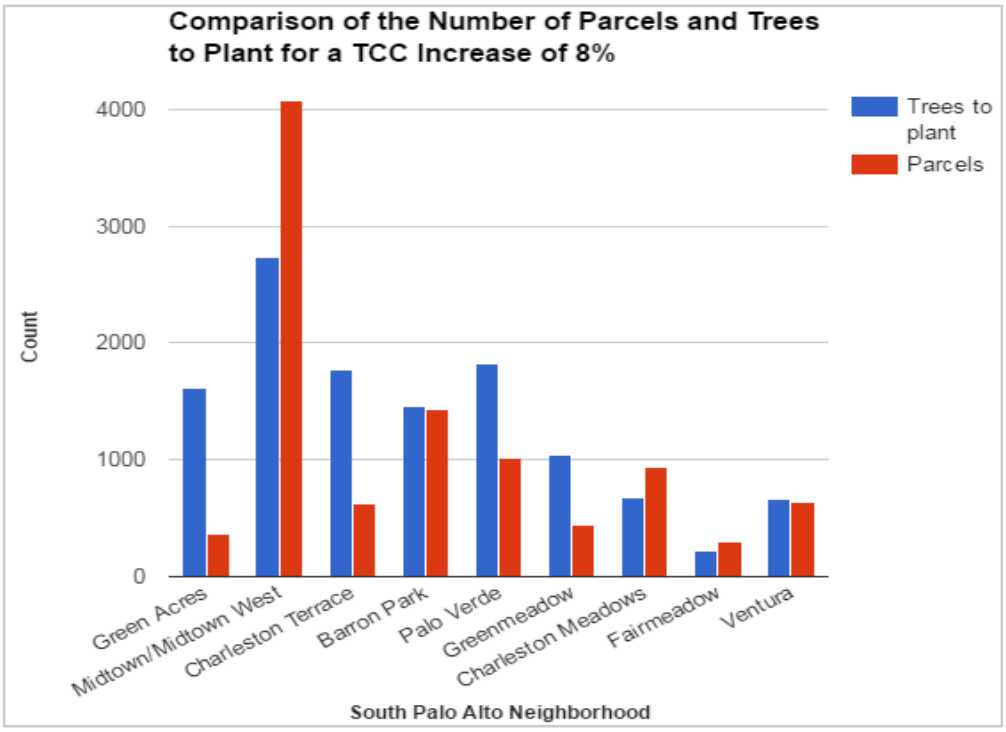


Figure 7. Comparison of the number of parcels and number of trees to be planted in each south Palo Alto neighborhood to reach a TCC increase of 8%.

Half of the neighborhoods have a comparable parcel count and number of trees to be planted to fill the target TCC areas. Yet some neighborhoods have a substantial gap, which may be a result of differences in zoning or size of the neighborhood. For example, Midtown is the largest neighborhood, therefore it will require more trees to be planted. But Midtown also has the most vacant street tree sites, and many single family residences and schools have new tree planting potential. In smaller neighborhoods with a distinct gap between parcel count and trees, such as Green Acres, it may be most beneficial to focus on the significant larger properties where there is greater potential to plant more than one tree (eg. school and public park properties).

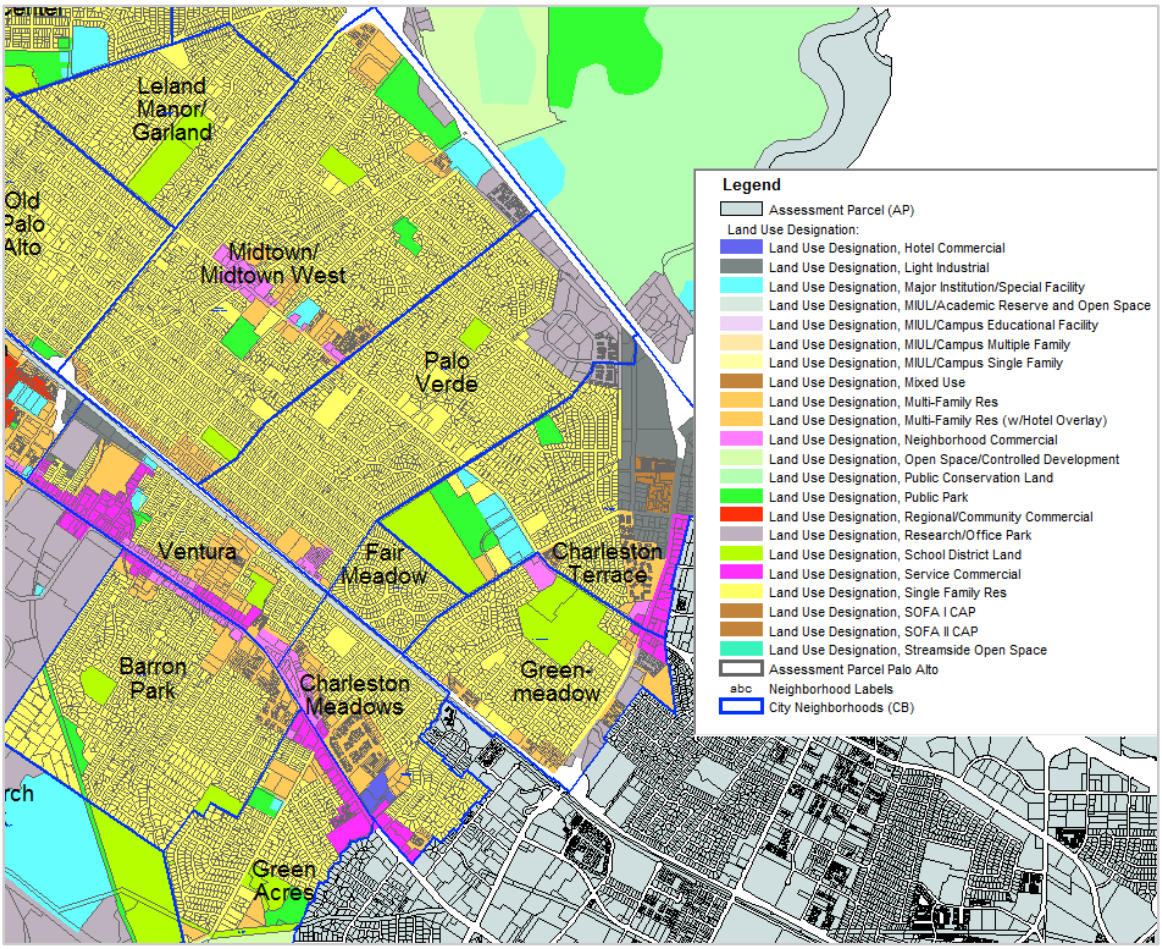


Figure 8. Land use designations for south Palo Alto neighborhoods.

In order to reach the proposed TCC goals, a timeline for implementation is critical for prioritizing plantings. The timeline for achieving the canopy goals depends largely on the level of commitment of the City and other stakeholders. We examined three possible commitment levels for what can be achieved based on the length of time that Palo Alto staff and residents are willing to work towards these TCC goals.

1) 10 Year Plan: If we wish to reach a canopy cover increase of 5-8% in the next 10 years, we need to plant approximately 10,000 trees (about 1,000 trees or more per year). Reaching a significant canopy within 10 years is challenging because young tree mortality and uneven growth are to be expected. Meanwhile, all 10,000 trees will not be planted in the first year, so it must be assumed that an average tree canopy spread of 20 feet across the new tree population will be reached closer to 15 to 20 years after. It is also preferable to continue planting and tracking growth after 10 years, therefore it would be very beneficial to extend tree planting to achieve greater tree canopy over a longer period of time. This option would yield more trees in a shorter time, thereby leveraging neighborhood enthusiasm and initiating canopy growth to be realized long-term.

2) 20 Year Plan: If we wish to reach a canopy cover increase of 8-12% in the next 20 years, we need to plant approximately 15,000 trees (about 750 trees or more per year). This commitment reduces the number of trees to be planted per year, but ultimately still achieves significant canopy growth with more tree age diversity.
3) 30 Year Plan: If we wish to reach a canopy cover increase of 10-15% in the next 30 years, we need to plant approximately 20,000 trees (about 650 trees or more per year). This commitment reduces the number of trees to be planted per year more than the other two options, but ultimately still yields canopy growth over a longer period of time. Neighborhood engagement is more challenging over a long period like this, and funding and staff oversight is much more unlikely. However, age diversity is increased and maintenance activity is more spread out, and with more time for planting there is the chance to double the number of new trees compared to the 10 Year Plan.

We recommend implementing the 10 Year Plan, but the Target TCC and approximate canopy increases are flexible because it is critical that each neighborhood have a direct hand in the goals and strategies for their area. These calculations are derived from somewhat inconsistent maps and imperfect data. Therefore, all strategies discussed are guidelines to be reviewed with neighborhood representatives and residents prior to creating neighborhood-specific management plans.

With ambitious goals we expect to encounter some challenges among different neighborhoods. Planting street trees in Barron Park may require additional soil remediation and planning where the right-of-way is generally used for car parking. Charleston Terrace and Ventura have a substantial amount of industrial and commercial zoned areas where there is limited open pervious area. Other challenges may arise, but we are confident that there will be significant community support to overcome obstacles in order to plant and care for trees.

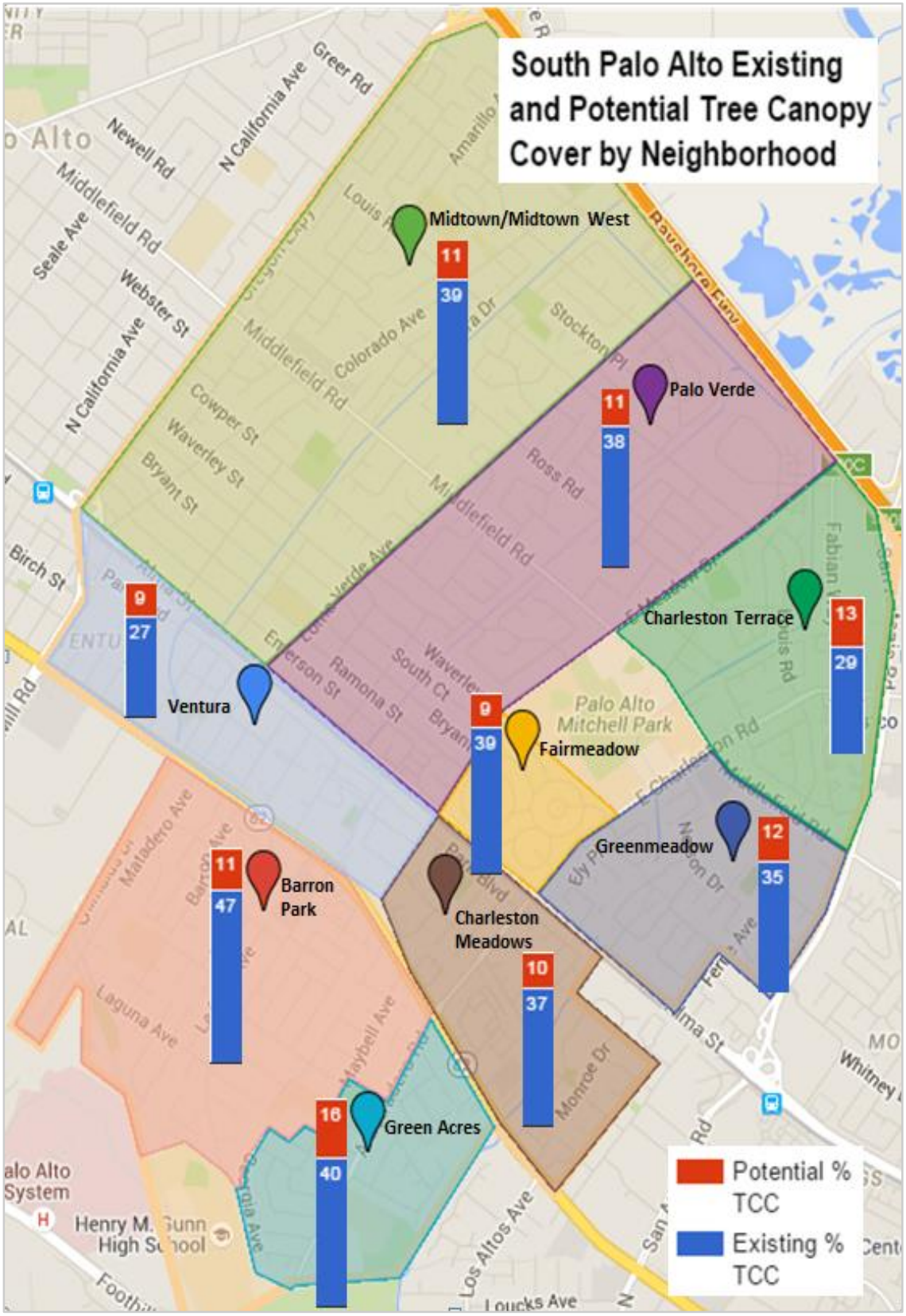


Figure 9. Map of the south Palo Alto neighborhoods
and the associated TCC increase after planting 20,000 trees.

3.2 Strategies to Achieve Canopy Cover Goals

In order to reach the tree canopy cover goals, the City of Palo Alto should strive to plant more trees and prevent tree canopy loss in south Palo Alto. The City should partner with Canopy to provide programs that plant trees on all lands with all people, increasing the number of trees to benefit communities where this is lacking. In addition, we present numerous opportunities to prevent canopy loss through retention of trees and appropriate replacement.

3.2.1. Create a campaign to plant more shade trees in south Palo Alto

We have provided estimates of how many trees need to be planted, and on what time frame, in order to reach our canopy goals. Where will these new trees be planted?

Staff has been inspecting vacant street tree sites in south Palo Alto and has found that, while infrastructure has rendered some sites obsolete, available vacant sites and potential new sites should increase the number of street trees. However, street trees account for only a small portion of the overall canopy and achieving a significant increase in canopy will rely on new trees being planted on private property.

This approach includes the following three components:

3.2.1a. Take advantage of opportunities in public right-of-way

Inter-departmental collaboration is needed to prioritize tree canopy expansion in south Palo Alto. For instance, enlisting the help of the Community Services department and Friends of the Palo Alto Parks will result in a heightened awareness of tree planting opportunities in parks and at community centers.

As the Public Works department implements the Urban Forest Master Plan's goal of bringing the stocking of street tree planting sites to 98%, it will prioritize the approximately 1,000 vacant sites in south Palo Alto. Furthermore, the preferred and restricted species list currently in development will prioritize large-growing trees that will be emphasized in our planting programs.

Address	Street	Side	Site	Species	Distance
4133	ABEL AV	Front	1	OBSOLETE SITE	10
4013	AMARANTA AV	Left	1	CALIFORNIA BLACK OAK	13
4112	AMARANTA AV	Left	1	COAST LIVE OAK	20
4133	AMARANTA AV	Front	1	CALIFORNIA BLACK OAK	30
4147	AMARANTA AV	Front	1	CRAPE MYRTLE 'MUSKOGEE'	50
4158	AMARANTA AV	Front	1	BLUE OAK	80
4154	AMARANTA CT	Left	1	COAST LIVE OAK	50
4154	AMARANTA CT	Left	2	COAST LIVE OAK	20
4029	ARBOL DR	Front	2	COAST LIVE OAK	60
644	BARRON AV	Front	1	BLUE OAK	36
4032	CAMPANA DR	Front	2	AUTUMN GOLD GINKGO	50
4131	CAMPANA DR	Front	1	AUTUMN PURPLE ASH	44
3736	CASS WY	Front	1	BLUE OAK	16
791	CEREZA DR	Front	1	RED OAK	12
606	CHIMALUS AV	Front	1	CRAPE MYRTLE 'MUSKOGEE'	25

Figure 10. Sample list of tree species recommendations for a subset of vacant street tree sites in Barron Park.

South Palo Alto Neighborhood	Vacant Street Tree Sites
Green Acres	12
Midtown/Midtown West	449
Charleston Terrace	39
Barron Park	68
Palo Verde	85
Greenmeadow	92
Charleston Meadows	49
Fairmeadow	71
Ventura	55
Total	920

Table 7. Estimated vacant street trees in each south Palo Alto neighborhood based on verified inventories from June 2016.

Capital Improvement Projects also have an important role to play in the early design stages when street trees should be incorporated. In particular, CIPs incorporating "complete street" principles offer valuable opportunities to enhance the streetscape by specifying larger planting

strips and appropriate shade tree species. CIP project managers should conduct specific outreach to Canopy, Friends of Parks groups, and other non-governmental environmental groups at the early stages of project planning.

3.2.1b. In partnership with Canopy, engage the south Palo Alto community in the campaign to plant more shade trees

We have evaluated strategies, programs, and incentives deployed successfully in other cities in the United States to plant trees on private property. Strategies to plant more trees include:

- Encourage and/or incentivize residents to plan for large shade trees in the initial stages of property redevelopment or landscape remodel. Reach out to architects, landscape architects, landscape designers, and consulting arborists to enlist their support.

> *"I notice new construction--both commercial and residential-- lacks trees. Partly this is due to "build to property line" design guideline: so the setbacks that provided visual relief are gone. No room for trees. This is one of the factors that has indelibly changed South Palo Alto: it needs to change back if we want to reverse the trend toward concrete everything. Please focus on that. Thanks."*
>
> *- Barron Park resident, 11/22/2015*

- Reach out to interested community members identified through our south Palo Alto Tree Canopy Community Survey and engage neighborhood associations to bring neighbors together and empower them to re-tree the public-right-of-way and their private yards through neighborhood tree planting and maintenance events. Provide workshops on how to care for young trees during the pivotal first three years after planting.

- Invite residents to register their new trees and track their growth using cutting edge technology such as Open Tree Map, a crowdsourcing tree mapping platform. This social media platform will encourage residents' involvement, increase education and awareness, and garner potential sponsors.

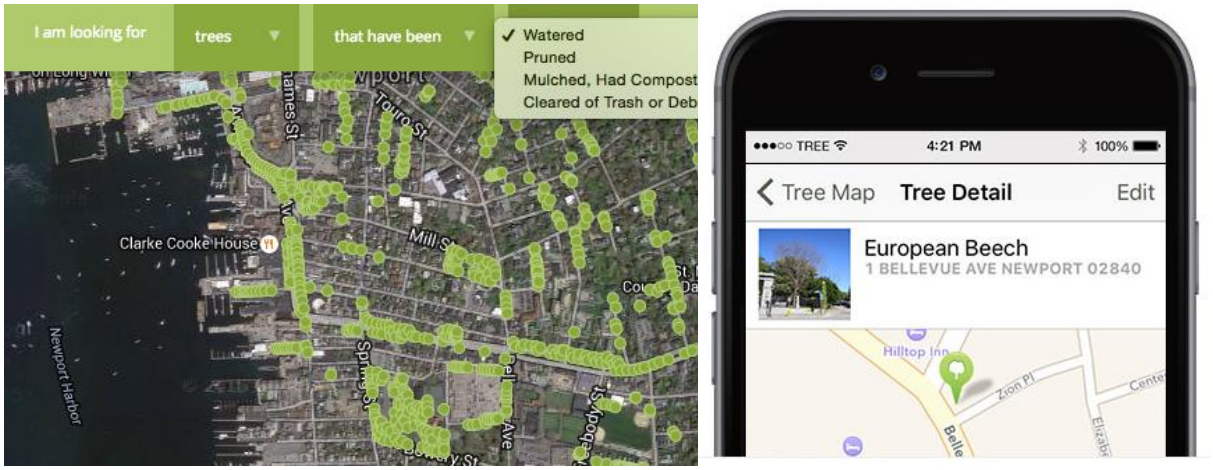


Figure 11. Snapshot of part of the Open Tree Map user interface (web browser and phone app).

"I strongly advocate finding and planting native trees as street trees in Palo Alto. We are falling behind on our neighboring cities in this front whereas we have been leaders in alternate energy and plastic bag bans. It is not sufficient to just have more green cover, it needs to be of higher quality to support the entire ecosystem. Canopy and the city of Palo Alto can and should work with organizations such as CNPS (California Native Plant Society) and Acterra to identify and use appropriate native trees."

- Midtown resident, 11/27/2015

- Position this effort in the context of enhancing the resilience of the landscape/ecosystem as a whole, and meshing it with efforts to re-oak Palo Alto, which will further motivate Palo Alto residents who are increasingly interested in the role of the natural environment in urbanized areas.

3.2.1c. Engage south Palo Alto businesses, the Palo Alto Unified School District, and the faith community

Respondents to the community survey expressed a desire to plant more trees on properties besides just the public right-of-way and private residences.

"It would be wonderful for churches to have help in identifying possible tree locations, acquiring trees and assistance in digging the holes for planting the trees. It is important to increase the canopy cover in south Palo Alto to provide songbird habitat, shade, and CO2 emissions absorption. Church sites are ideal candidates for this."

- Barron Park resident, 11/30/2015

- Partner with businesses, schools, and churches to ensure that trees be prioritized. These property owners own and maintain a significant share of landscapes in south Palo Alto and have a lot to gain from a greater tree canopy.

South Palo Alto Neighborhood	Number of Parcels	Schools & Childcare	Parks & Community Centers	Churches/Faith Community
Green Acres	363	Terman Middle School, Juana Briones Elementary, Bowman International School, Palo Alto Montessori School, Whistlestop Child Development Center, Young Life Christian Preschool	Terman Park, Juana Briones Park	Palo Alto Christian Reformed Church
Midtown/Midtown West	4072	El Carmelo Elementary, Fairmeadow Elementary, Ohlone Elementary, Keys School, Emerson School, Grace Lutheran Preschool, Love'n'Care Christian Preschool, Mini Infant Center of Palo Alto, Ohlone Kids' Club (PACCC), Palo Alto Friends Nursery School	Greer Park, Henry Seale Park, Hoover Park	Bridgeway Church, Saint Mark's Episcopal Church, First Christian Church, Grace Lutheran Church, First Church-Christ Scientist, Palo Alto Buddhist Temple
Charleston Terrace	628	Covenant Children's Center, Sunshine Preschool Montessori, Challenger School, Children's Pre-School Center, Good Neighbor Montessori, Young Fives and PreSchool Family, Kehillah Jewish High School, Palo Alto Prep School	Don Jesus Ramos Park	C3 Silicon Valley, The Church of Jesus Christ of Latter-day Saints, Keddem Congregation
Barron Park	1437	Barron Park Elementary, Gunn High School, Barron Park Children's Center, Barron Park Preschool, Barron Park Kids' Club, Juana Briones Kids' Club	Cornelis Bol Park	Congregation Kol Emeth, Congregation Emek Beracha
Palo Verde	1019	Palo Verde Kids' Club, The Girls' Middle School, Palo Verde Elementary School	Greenmeadow Park (private), Palo Alto Family YMCA	Covenant Presbyterian Church, Cornerstone Community Church, University AME Zion Church, Peninsula Bible Church, Russian Orthodox Church Hall, Palo Alto Church of Christ, St. Thomas Aquinas Parish, Our Lady of the Rosary Church, Unity Palo Alto

Greenmeadow	437	Montessori School of Los Altos, Palo Alto Infant Toddler Center, Palo Alto Prep School, Gideon Hausner Jewish Day School	Cubberley Community Center	St. Andrew's United Methodist Church, Palo Alto Vineyard Church, Christ Temple Community Church, Congregation Etz Chayim
Charleston Meadows	941	Growing Tree Preschool, Ventura Community Center, Children's Corner, [Monroe Park: Los Altos School District - Santa Rita School, Egan Junior High School; Mtn. View - Los Altos Union High School District - Los Altos High School]	Don Secundino Robles Park, Monroe Mini Park	
Fairmeadow	301	Besse Bolton Kids' Club, Covenant Children's Center, Ellen Thacher Children's Center, Hoover Kids' Club, Palo Alto Infant Toddler Center, Fairmeadow Elementary School, Herbert Hoover Elementary School, Jane Lanthrop Stanford Middle School	Mitchell Park, Community Center, and Library	Unitarian Universalist Church of Palo Alto
Ventura	635	Country Day Little School, Heffalump Cooperative Nursery, Leaping Lizards Nature Awareness Preschool, Sojourner Truth Child Development Center	Boulware Park, Ventura Community Center	Church of Scientology Mission of Palo Alto
Total	9833	55	15	27

Table 8. Overview of some opportunities for tree planting on parcels other than single- and multi-family residential.

- Enforce the parking lot 50% shading ordinance to help achieve tree canopy goals.

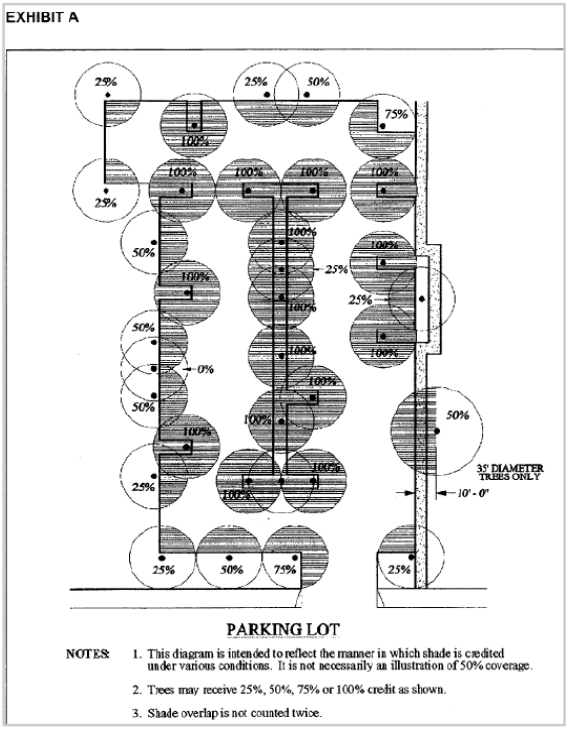


Figure 12. Exhibit A from Addendum 9 of the City of Palo Alto Zoning Ordinance 18.40.130 - Parking Lot Shading Guidelines.

3.2.2. Prevent tree canopy loss

"Very concerned by the recent PG&E plans to remove trees in the South of Palo Alto area. South of Palo Alto has been increasingly impacted by traffic and commercial development without a strategic and commensurate plan regarding its tree planting and green environment and infrastructure. Together with the planting, there must also be a corresponding maintenance plan and sound guidelines (agreed and supported by the community) for their care and removal: utilities, water consumption, pruning, root growth/sidewalk maintenance, etc."

- Saint Claire Gardens resident, 12/02/2015

Many of the Urban Forest Master Plan programs address forest management strategies that will directly affect south Palo Alto. Emphasis should be placed on efforts that minimize tree removals and maximize appropriate tree maintenance. Preventing tree canopy loss can best be accomplished by employing the following measures:

3.2.2a. Examine challenges in public tree maintenance contracts

- Public Tree Pruning and Removal and Line Clearing Contracts require inspection reports that are verified by City staff. Best Management Practices and American National Standards Institute (ANSI) sections are cited to represent the industry criteria for performing tree care operations, ensure quality control, and justify decisions to residents.

- Work toward a seven year or shorter public tree pruning cycle that takes into consideration the needs of different types of trees.

- Redouble interdepartmental collaboration efforts to communicate tree removal and maintenance to residents in a timely and effective manner while maintaining contract objectives. Constraints in time and funding, and advanced challenges such as integration of above and below ground fiber optics, will be reviewed in detail to ensure south Palo Alto's public and private trees are prioritized.

- Be vigilant of and oppose as is reasonably possible large tree removal projects planned in Palo Alto by agencies such as PG&E, the SFPUC, or Cal Trans.

3.2.2b. Enhance communication

Responses to the UFMP survey consistently stated that residents appreciate communication from the City and would like to receive more. Addressing this "hot topic" is critical to building better relationships with residents and among different City departments.

- Make the City's Urban Forestry code and requirements more accessible and understandable to the public through community meetings, workshops, and online resources. Make the Palo Alto Tree Technical Manual, Tree Ordinance, and information about the impact of development on trees readily available to residents, developers, realtors, and landscape professionals.

"I've lived in South Palo Alto over 55 years and am still unclear about what makes a tree a "street tree" - distance from the (rolled) curb? Who planted it and when? What kind of tree it is? I would like to see more clarity and information available about this - who is responsible for planting, trimming, checking? What kinds are appropriate and/or available? I would also like to see something on the City website that identifies the common street trees around Palo Alto. A picture and description with names and characteristics would be helpful when trying to decide on a tree or in discussions about them. I appreciate the City's work on this. Thank you."

- South of Midtown resident, 11/23/2015

- Establish a new standard for two-way communication with the public and allow residents to report public tree-related concerns to staff easily. Provide timely and effective follow-up. Increase communication to residents about scheduled activities in the right-of-way, such as tree planting, pruning, and removals.

"As a long-time homeowner-45+ years- I feel that there needs to be more specific communication. When does the City prune existing trees? How can Homeowners work with the city to care for their trees? Recommendations from the City to care for City Trees. Recommendation for trees that would grow well in my area. Assurance that trees planted are non-invasive and less likely to affect sewers and foundation."

- South of Midtown resident, 11/23/2015

3.2.2c. Address concerns arising from the drought

- Collaborate with City of Palo Alto Utilities to educate the public about the available resources and justification for tree watering. Trees should be priority recipients of available water resources even during drought, and new tree owners need to be informed of the importance of regular watering for young tree survival.

- Assess watering needs for new tree establishment, and list viable sources of funding for services such as watering trucks. No matter what species, right-of-way trees and private property trees need to be watered regularly in the early establishment stage. Novel water sources may include dewatering stations, recycled water of adequate quality, greywater, and collected rain water.

3.2.2d. Emphasize urban forest management in City long-range planning documents

- Incorporate the role of the urban forest in the Palo Alto Comprehensive Plan and the Sustainability and Climate Action Plan and demonstrate how urban trees help achieve these plans' goals. Dedication of resources to south Palo Alto's trees should be recognized in these documents, addressing the need for long-term tree planting and maintenance.

- Formalize the South Palo Alto tree planting campaign, to plant 10,000 trees in 10 years, in the final draft of the Urban Forest Master Plan.

- Coordinate efforts to contribute to achieving overlapping goals listed in the City Parks, Trails, Natural Opens Spaces and Recreation Master Plan. Address needs in urban canopy target areas, along pollinator pathways, and in "desert areas," to name a few.

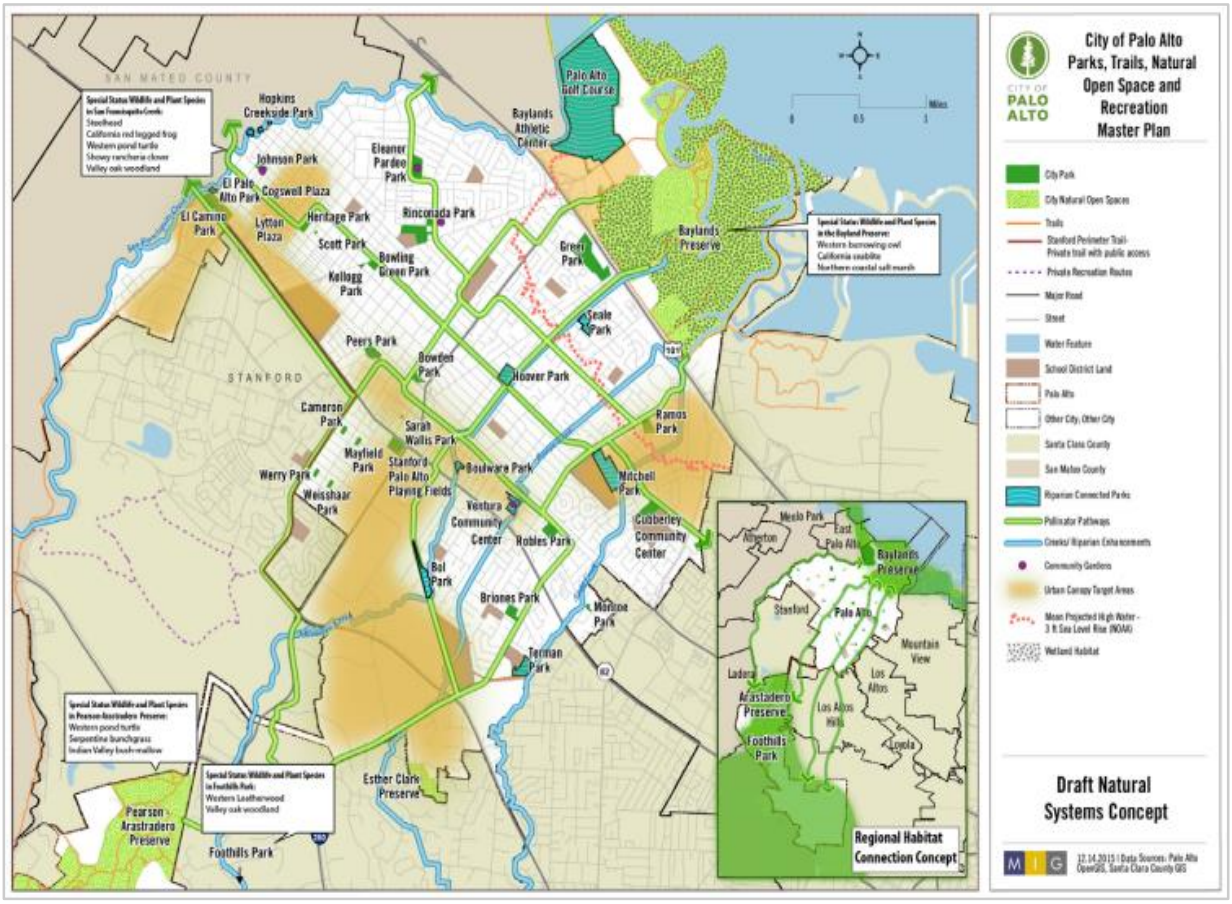


Figure 13. City of Palo Alto Parks, Trails, Natural Open Space and Recreation Master Plan has goals that may be accomplished through coordination with urban forestry efforts.

3.3 Draft Implementation Plan

1. Project (code) Name: South Palo Alto Tree Planting Campaign

The South Palo Alto Tree Planting Campaign will engage the community in south Palo Alto to plant public and private trees, and work with the City to prevent canopy loss.

2. Sponsorship request: $To Be Determined

We anticipate that the proposed project budget will require various funding streams including an anticipated amendment to the City of Palo Alto's contract with Canopy, City of Palo Alto Forestry Fund, Canopy unrestricted funds, and corporate or foundation grants such as the 2016 Google Landscape resilience sponsorship.

3. Strategy

Recognizing the need for a comprehensive approach to managing the urban forest, the Palo Alto City Council adopted the first Palo Alto Urban Forest Master Plan in 2015 and instructed City Staff to work with Canopy to address the canopy disparity between north and south Palo Alto. In some south Palo Alto neighborhoods, tree canopy cover is about half that of North Palo Alto.

Canopy's study shows that there is space for potentially planting 20,000 trees, mostly on private property. Conservatively, we estimate that a goal of 10,000 new trees in South Palo Alto in the next ten years is both aspirational and achievable and would take us halfway to the number of new trees needed to achieve a goal of increasing the south Palo Alto tree canopy cover by 15% over twenty years.

We are confident that the time is right and that the project will enjoy visibility and support from the City, the community at large, and the strong environmental and conservation community advocates in town.

4. South Palo Alto Tree Planting Campaign

From July 2016 to June 2017, we propose that Canopy perform the following tasks:

- Design a program that will increase the tree canopy cover in south Palo Alto over the next 10 years. This program will include:
    - Tree plantings in the public right of way (street and park trees) in partnership with the City of Palo Alto Urban Forestry Group
    - Outreach to residents (directly and through neighborhood associations, social media, etc.)
    - Outreach to commercial and institutional landowners (businesses, school district, faith communities, among others)
- Pilot the program in one or several neighborhoods
- Create a program to engage the community in the effort to plant and record shade trees on private property, using the OpenTreeMap platform that the City of Palo Alto plans to acquire in the summer of 2017

- Test possible incentive programs
- Incorporate efforts of the Re-Oaking Palo Alto program
- Assess the pilot program
- Create a plan for full deployment
- Incorporate landscape resilience principles into Palo Alto Preferred and Restricted Tree Species List to be developed in 2016-17

5. Team

Canopy Urban Forest Technician Elise Willis will lead this project under the supervision of Michael Hawkins, Program Director, and Catherine Martineau, Executive Director. Advisors will include Kelaine Ravdin (Urban Ecologist, Urban Ecos on the creation of public engagement programs on the OpenTreeMap platform) and Bill Courington (original Oakwell Survey designer and project lead.)

4.0 References[1]

American Forests. (n.d.). *Urban Forests Case Studies: Challenges, Potential and Success in a Dozen Cities*. Retrieved from http://www.americanforests.org/our-programs/urbanforests/urban-forests-casstudies/

From Street Trees to Sustainability: Science, Practice, Tools. (2016). Retrieved from http://dels.nas.edu/global/basc/uf-presentations

Interview with Susan Rosenberg [Personal interview]. (2015, October 28).

Interview with Annette Glanckopf [Personal interview]. (2015, October 29).

Interview with Dave Dockter [Personal interview]. (2016, January 24).

Interview with Greg McPherson [Telephone interview]. (2016, February 11).

Interview with Lara Roman [Telephone interview]. (2016, February 25).

Interview with Alice Ewen [Telephone interview]. (2016, March 21).

Interview with Dana Karcher [Telephone interview]. (2016, March 25).

Interview with Michael Galvin [Telephone interview]. (2016, April 15).

Interview with Rachel Malarich [Telephone interview]. (2016, April 18).

Ko, Yekang; Lee, Jun-Hak; McPherson, E. Gregory; Roman, Lara A. 2015. Factors affecting long-term mortality of residential shade trees: evidence from Sacramento, California. Urban Forestry & Urban Greening. 14(3): 500-507. Retrieved from http://www.fs.fed.us/psw/publications/mcpherson/psw_2015_mcpherson004_ko.pdf?

Ko, Yekang; Lee, Jun-Hak; McPherson, E. Gregory; Roman, Lara A. 2015. Long-term monitoring of Sacramento Shade program trees: tree survival, growth and energy-saving performance. Landscape and Urban Planning. 143: 183-191. Retrieved from http://www.fs.fed.us/psw/publications/mcpherson/psw_2015_mcpherson005_ko.pdf?

Locke, Dexter; Grove, J. Morgan; Lu, Jacqueline W.T.; Troy, Austin; O'Neil-Dunne, Jarlath P.M.; Beck, Brian. 2010. Prioritizing preferable locations for increasing urban tree canopy in New York City. Cities and the Environment 3(1):18 p. Retrieved from http://www.nrs.fs.fed.us/pubs/jrnl/2010/nrs_2010_locke_001.pdf

Locke, Dexter H.; Grove, J. Morgan; Galvin, Michael; O'Neil-Dunne, Jarlath P.M.; and Murphy, Charles (2013) "Applications of Urban Tree Canopy Assessment and Prioritization Tools:

[1] Not all references were specifically cited in this report, but were part of the literature review/research and will be used during program implementation.

Supporting Collaborative Decision Making to Achieve Urban Sustainability Goals," Cities and the Environment (CATE): Vol. 6: Iss. 1, Article 7. Available at: http://digitalcommons.lmu.edu/cate/vol6/iss1/7

McHale, M.R.; McPherson, E.G.; Burke, I.C. 2007. The Potential Of Urban Tree Plantings To Be Cost Effective In Carbon Credit Markets.

McPherson, E.G.; Simpson, J.R. 2003. Potential Energy Savings In Buildings By An Urban Tree Planting Programme In California. Retrieved from http://www.fs.fed.us/psw/publications/mcpherson/psw_2003_mcpherson005.pdf?

McPherson, Gregory E.; Simpson, James R.; Xiao, Qingfu; Chunxia, Wu 2008. Los Angeles 1-Million tree canopy cover assessment. Gen. Tech. Rep. PSW-GTR-207. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 52 p. Retrieved from http://www.fs.fed.us/psw/publications/documents/psw_gtr207/psw_gtr207.pdf?

McPherson, G., Simpson, J., O'Neil-Dunne, J., Xiao, Q., Bartens, J., & C. (2013). *Urban Forest Inventory and Assessment Pilot Project Phase Two Report* (USA, City of San Jose). Retrieved from https://www.sanjoseca.gov/DocumentCenter/View/23211

McPherson, E. Gregory. 2014. Monitoring Million Trees LA: Tree performance during the early years and future benefits. Journal of Arboriculture & Urban Forestry. 40(5): 285-300. Retrieved from http://www.fs.fed.us/psw/publications/mcpherson/psw_2014_mcpherson003.pdf?

Participating Neighborhood Associations. (n.d.). Retrieved from http://www.paneighborhoods.org/

Roman, Lara A.; McPherson, E. Gregory; Scharenbroch, Bryant C.; Bartens, Julia. 2013. Identifying Common Practices And Challenges For Local Urban Tree Monitoring Programs Across The United States. Retrieved from http://www.fs.fed.us/nrs/pubs/jrnl/2013/nrs_2013_roman_001.pdf?

Roman, Lara A. 2014. How many trees are enough? Tree death and the urban canopy. Scenario Journal. Scenario 04. 8 p. Retrieved from http://www.fs.fed.us/nrs/pubs/jrnl/2014/nrs_2014_roman_001.pdf?

Roman, Lara A.; Battles, John J.; McBride, Joe R. 2014. Determinants of establishment survival for residential trees in Sacramento County, CA. Landscape and Urban Planning. 129: 22-31. Retrieved from http://www.fs.fed.us/nrs/pubs/jrnl/2014/nrs_roman_2014_002.pdf?

Roman, Lara A.; Walker, Lindsey A.; Martineau, Catherine M.; Muffly, David J.; MacQueen, Susan A.; Harris, Winnie. 2015. Stewardship Matters: Case Studies In Establishment

Success Of Urban Trees. Retrieved from http://www.fs.fed.us/nrs/pubs/jrnl/2015/nrs_2015_roman_001.pdf?

Sartor, M., Passmore, W., Humble, G., Dockter, D., Krebs, E., Anderson, D., . . . T. (n.d.). *Sustaining the Legacy: City of Palo Alto Urban Forest Master Plan*. Retrieved from http://www.cityofpaloalto.org/civicax/filebank/documents/36187

Urban, J. (2013, November 11). An Open Letter to the Complete Streets Movement. Retrieved from http://www.deeproot.com/blog/blog-entries/an-open-letter-to-the-complete-streets-movement

Wua, Chunxia; Xiaoa, Qingfu; McPherson, Gregory E. 2008. A Method For Locating Potential Tree-Planting Sites In Urban Areas: A Case Study Of Los Angeles, Usa. Retrieved from http://www.fs.fed.us/psw/publications/mcpherson/psw_2008_mcpherson001.pdf?

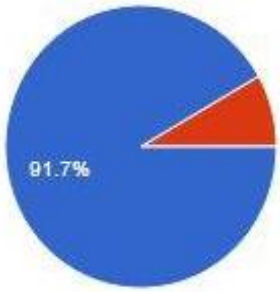
5.0 Appendices

5.1 South Palo Alto Tree Canopy Community Survey Responses

Close to 500 residents responded, 92% of which were south Palo Alto residents. The greatest percentage of responses came from Barron Park, Midtown, Palo Verde, Greenmeadow, and Green Acres. The majority of respondents were single family residence homeowners, who revealed their desire for more trees.

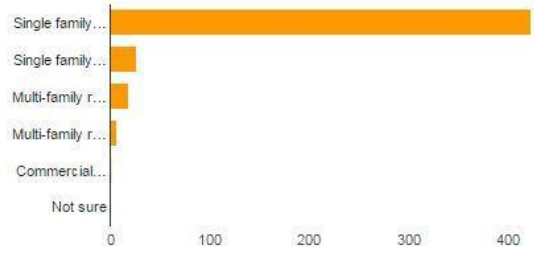
The full list of written responses has been omitted from this report, but may be requested.

Do you live or own property in South Palo Alto?



Yes	431	91.7%
No	39	8.3%

Which category applies to you?

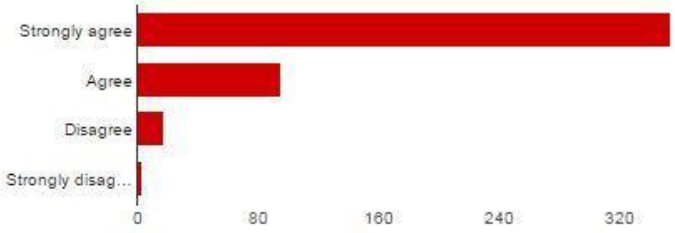


Single family residence homeowner	423	90%
Single family residence renter	26	5.5%
Multi-family residence owner (apartment, condo, duplex, etc)	18	3.8%
Multi-family residence renter (apartment, condo, duplex, etc)	7	1.5%
Commercial property owner/renter	1	0.2%
Not sure	0	0%

In which neighborhood do you live or own property?

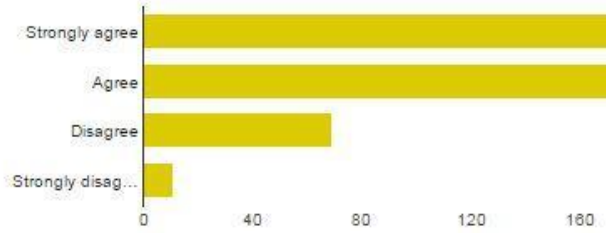
Ventura	11	2.3%
Midtown	102	21.7%
Palo Verde	53	11.3%
St. Claire Gardens	4	0.9%
South of Midtown	22	4.7%
Adobe Meadow	21	4.5%
Charleston Gardens	1	0.2%
The Greenhouse	0	0%
Greendell	3	0.6%
Greenmeadow	47	10%
Walnut Grove	3	0.6%
Fairmeadow	8	1.7%
Charleston Meadows	14	3%
Monroe Park	4	0.9%
Palo Alto Orchards	0	0%
Barron Park	120	25.5%
Green Acres	27	5.7%
Greater Miranda	2	0.4%
Esther Clark Park	0	0%
Palo Alto Hills	0	0%
Not sure	2	0.4%
North Palo Alto neighborhood	17	3.6%
Other	22	4.7%

There should be more trees in South Palo Alto. [What is your opinion of the trees in South Palo Alto?]



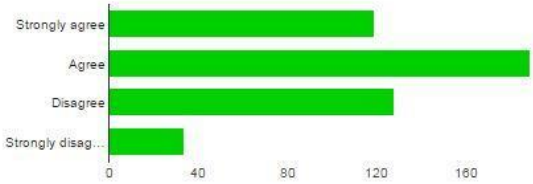
Strongly agree	354	75.3%
Agree	95	20.2%
Disagree	18	3.8%
Strongly disagree	3	0.6%

I prefer street trees located in a planter strip. [What is your opinion of the trees in South Palo Alto?]



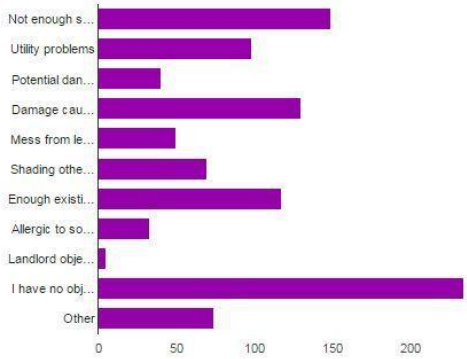
Strongly agree	195	41.5%
Agree	195	41.5%
Disagree	69	14.7%
Strongly disagree	11	2.3%

I prefer street trees located behind the sidewalk in the front yard (rolled curb) [What is your opinion of the trees in South Palo Alto?]



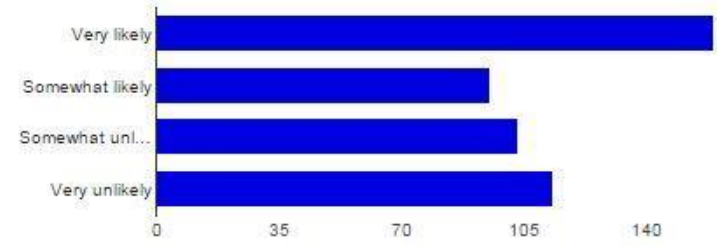
Strongly agree	119	25.3%
Agree	189	40.2%
Disagree	128	27.2%
Strongly disagree	34	7.2%

We would like to know what prevents people from planting trees on their property. Identify the issue(s) that could prevent tree planting on your property:



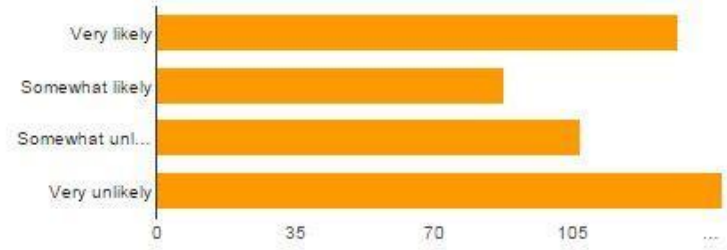
Not enough space	149	31.7%
Utility problems	98	20.9%
Potential danger from falling branches	40	8.5%
Damage caused by tree roots	130	27.7%
Mess from leaves or fruit	50	10.6%
Shading other plants too much	70	14.9%
Enough existing trees	117	24.9%
Allergic to some trees	33	7%
Landlord objects to new trees	5	1.1%
I have no objections to planting more trees	234	49.8%
Other	74	15.7%

Would you like new trees in your front yard? [Make a choice for each statement:]



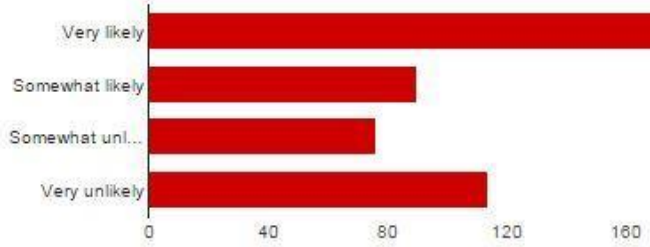
Very likely	159	33.8%
Somewhat likely	95	20.2%
Somewhat unlikely	103	21.9%
Very unlikely	113	24%

Would you like new trees in your back yard? [Make a choice for each statement:]



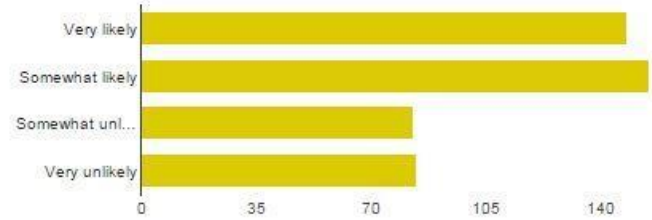
Very likely	132	28.1%
Somewhat likely	88	18.7%
Somewhat unlikely	107	22.8%
Very unlikely	143	30.4%

Would you like new street trees in front of your property? [Make a choice for each statement:]



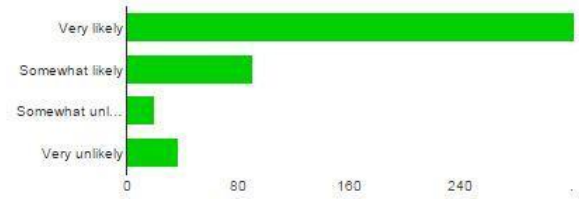
Very likely	190	40.4%
Somewhat likely	90	19.1%
Somewhat unlikely	76	16.2%
Very unlikely	114	24.3%

Would you participate in a South Palo Alto neighborhood tree planting? [Make a choice for each statement:]



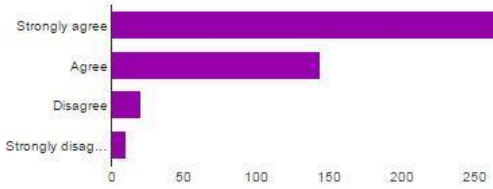
Very likely	148	31.5%
Somewhat likely	155	33%
Somewhat unlikely	83	17.7%
Very unlikely	84	17.9%

Would you water and take care of a new street or yard tree if one was provided to you? [Make a choice for each statement:]



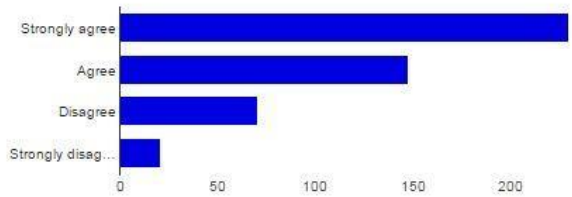
Very likely	322	68.5%
Somewhat likely	91	19.4%
Somewhat unlikely	20	4.3%
Very unlikely	37	7.9%

The City/Canopy should launch a campaign to plant more trees and engage the community. [Make a choice for each statement:]



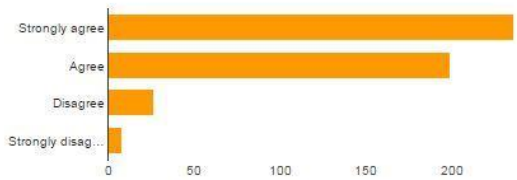
Strongly agree	296	63%
Agree	144	30.6%
Disagree	20	4.3%
Strongly disagree	10	2.1%

The City should provide incentives such as utility rebates for new private tree planting. [Make a choice for each statement:]



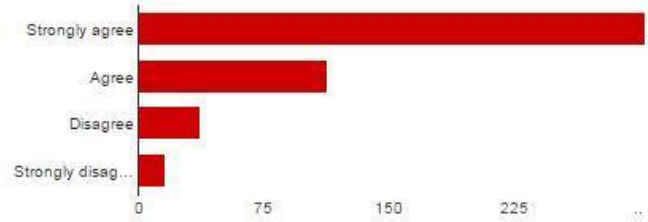
Strongly agree	230	48.9%
Agree	148	31.5%
Disagree	71	15.1%
Strongly disagree	21	4.5%

The City Urban Forestry tree planting requirements should be more accessible and understandable. [Make a choice for each statement:]



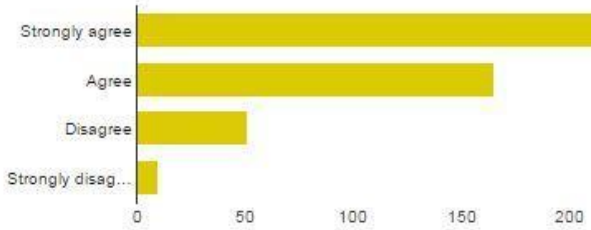
Strongly agree	236	50.2%
Agree	199	42.3%
Disagree	27	5.7%
Strongly disagree	8	1.7%

Private development projects should be required to plant more trees. [Make a choice for each statement:]



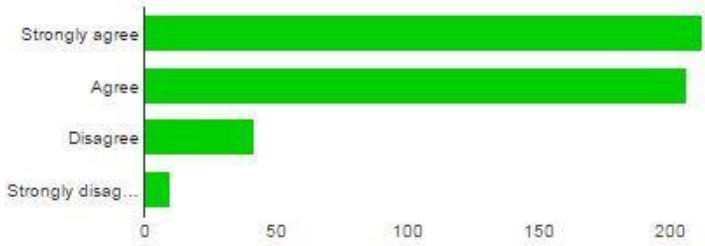
Strongly agree	304	64.7%
Agree	113	24%
Disagree	37	7.9%
Strongly disagree	16	3.4%

South Palo Alto needs neighborhood-specific tree planting plans. [Make a choice for each statement:]



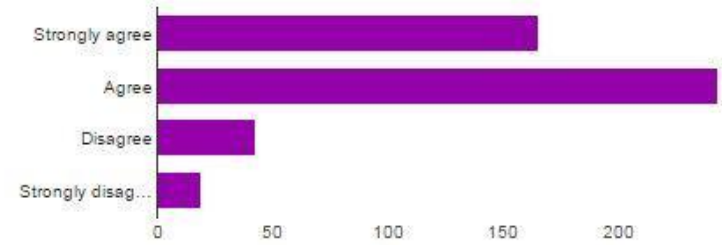
Strongly agree	244	51.9%
Agree	165	35.1%
Disagree	51	10.9%
Strongly disagree	10	2.1%

Palo Alto residents need tree care information and resources. [Make a choice for each statement:]



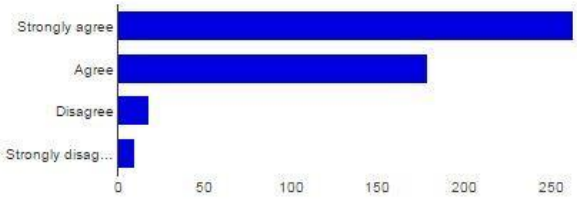
Strongly agree	212	45.1%
Agree	206	43.8%
Disagree	42	8.9%
Strongly disagree	10	2.1%

Residents should be allowed to help care for street trees. [Make a choice for each statement:]



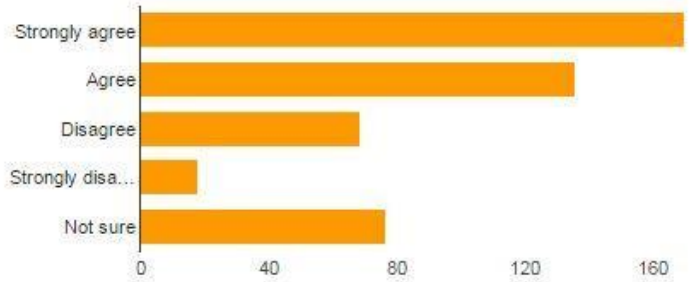
Strongly agree	165	35.1%
Agree	243	51.7%
Disagree	43	9.1%
Strongly disagree	19	4%

Residents and businesses should be able to opt in for free private and street trees. [Make a choice for each statement:]



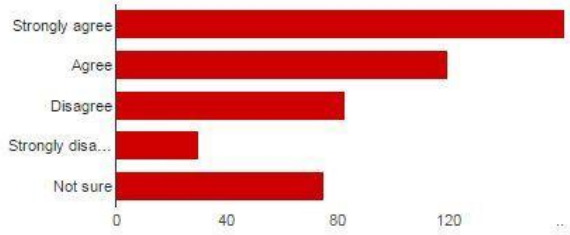
Strongly agree	263	56%
Agree	179	38.1%
Disagree	18	3.8%
Strongly disagree	10	2.1%

The City should have stronger street tree planting requirements. [Make a choice for each statement:]



Strongly agree	**170**	36.2%
Agree	**136**	28.9%
Disagree	**69**	14.7%
Strongly disagree	**18**	3.8%
Not sure	**77**	16.4%

Existing regulations that prevent street tree removal should be enforced more strictly. [Make a choice for each statement:]



Strongly agree	**162**	34.5%
Agree	**120**	25.5%
Disagree	**83**	17.7%
Strongly disagree	**30**	6.4%
Not sure	**75**	16%

5.2 Methodology

I. Data collection
   a. South Palo Alto Tree Canopy Community Survey - distributed online with one-month response period from November 20, 2015 to December 21, 2015.
      i. Survey purpose: collect South Palo Alto individual resident's objections, opinions, and personal views about street and yard trees.
      ii. Survey goal: gather quantitative and qualitative data about South Palo Alto resident preferences, in order to help guide the recommendations for the Canopy Disparity Report.
      iii. Survey objectives:
         1. Distribute short survey through NextDoor, PAN listservs, website posting, and various news outlets to get as many responses as possible.
         2. Analyze survey responses to set priorities and give direction for report recommendations.
         3. Introduce community members to the study and open communication for future surveys and/or community meetings prior to the report presentation in June 2015.
      iv. Target audience: South Palo Alto residents and other community members

II. Calculating tree canopy cover goals
   a. Using the land cover types by neighborhood supplied in the UC Davis report, we translated the percent coverage to area in square meters.

   b. Pervious area was re-named as Vegetated Possible TCC. Some of this area will be compromised and unavailable for planting, which is why TCC goals were calculated based on $Vegetated\ TCC \div 2$ and $Vegetated\ Possible\ TCC \div 4$

   c. Calculating the number of trees to be planted to achieve the TCC goal (area coverage):
      i. Based on an average tree crown diameter spread of 20 feet
      ii. $A = \pi r^2$
         1. Area covered by a tree with a 20-foot crown diameter is about 30 m^2
      iii. $Number\ of\ trees\ to\ plant = (Vegetated\ Possible\ TCC \div 2) \div 30$
      or
      iv. $Number\ of\ trees\ to\ plant = (Vegetated\ Possible\ TCC \div 4) \div 30$

   d. $Neighborhood\ TCC\ after\ new\ tree\ planting\ \% = (((Vegetated\ Possible\ TCC \div 2) + Existing\ TCC) \div Total\ area) \times 100$

   e. $Neighborhood\ TCC\ increase\ after\ new\ tree\ planting\ \% = ((TCC\ after\ new\ tree\ planting\ \% \div Average\ TCC\ 2010\ \%) - 1) \times 100$

f. Calculating the current TCC in south Palo Alto based on 2010 data:
$2010\ Existing\ TCC\ area \div Total\ area$
4,670,127 m^2 ÷12,560,862 m^2 = 37% TCC

g. Proposed TCC area increase based on $Vegetated\ Possible\ TCC \div 2$
$=2010\ Existing\ TCC\ area\ + (Vegetated\ Possible\ TCC \div 2)$
4,670,127 m^2 + 719,499 m^2 = 5,389,626 m^2

h. Proposed TCC % increase based on $Vegetated\ Possible\ TCC \div 2$
$=((Vegetated\ Possible\ TCC \div 2) \div 2010\ Existing\ TCC\ area) \times 100$
(719,499 m^2÷4,670,127 m^2)×100 = 15% TCC

i. Resultant increase in TCC based on $(Vegetated\ Possible\ TCC \div 2)$
Percentage points = 6%
Percent increase = 15%

j. Proposed TCC area increase based on $Vegetated\ Possible\ TCC \div 4$
$=2010\ Existing\ TCC\ area\ + (Vegetated\ Possible\ TCC \div 2)$
4,670,127 m^2 + 359,750 m^2 = 5,029,876 m^2

k. Proposed TCC % increase based on $Vegetated\ Possible\ TCC \div 2$
$=((Vegetated\ Possible\ TCC \div 2) \div 2010\ Existing\ TCC\ area) \times 100$
(359,750 m^2÷4,670,127 m^2)×100 = 8% TCC

l. Resultant increase in TCC based on $(Vegetated\ Possible\ TCC \div 2)$
Percentage points = 3%
Percent increase = 8%

5.3 Overview of Programs Employed by Other Cities

Urban Forests Case Studies - Challenges, Potential and Success in a Dozen Cities was presented by American Forests in 2015 to provide valuable information about urban forestry programs across the U.S. Below is an outline of some of the programs reported in each of the cities, some which Palo Alto already employs, and others that may be reviewed for deployment in Palo Alto.

"Unlike traditional infrastructure, such as pipelines and, buildings and roadways, urban forests appreciate in value over time, meaning a low-cost solution now in the form of urban forest investments becomes a long-term benefit."

Integrating Green Infrastructure solutions - Stormwater and Watersheds, Energy and Heat Islands

1. Portland, Oregon
    a. Treebate: incentive program for private landowners to plant trees, in which the City takes the receipt and in the homeowner's utility bill they receive credit for half the purchase of the purchase price of the tree up to $50.
    b. City Urban Forestry has a Neighborhood Tree Steward Program, a movement which "looks at neighborhoods as forest management units" that have specific inventories and developed unique tree plans with the neighborhood associations/residents.
    c. Friends of Trees (nonprofit) contracts with City to: organize neighborhood plantings, send out stewards for tree care, community engagement aspects, etc.
        i. "Opt-in" versus "opt-out" model for free trees - opt-out might get more trees in the ground, but opt-in may lead to higher survival rates because people want the trees.
2. Philadelphia, Pennsylvania
    a. TreePhilly (City Parks & Rec program) identified 8 target neighborhoods and coordinated with "friends" groups and nonprofits to "build the capacity of citizens to become stewards."
    b. City Water Dept working with Parks & Rec to develop cost sharing for tree planting in stormwater management pits (ie vegetated bioswales) to introduce funds for green stormwater infrastructure installation and maintenance.
3. Washington, D.C.
    a. Casey Trees (nonprofit) focusing on tree planting, care, education, policy and advocacy.
    b. Urban Forestry Administration - part of DDOT
        i. Canopy Keepers program - allows residents to apply to adopt a tree near their property and UFA delivers a slow-drip watering tub to be filled by the adopter weekly.
        ii. Through the American Recovery and Reinvestment Act, UFA received more than $4M to remove paving, expand tree wells, and create new planting sites.
4. Milwaukee, Wisconsin
    a. City Urban Forestry staff

i. Environmental Services created vegetated bioswales along roadways - lower cost when focusing on medians because only needed curb cuts around the sewer grates.
ii. Planning dept involves Environmental Services early in project planning to integrate trees at the start.
iii. City tree nursery is 160 acres - lower cost than purchasing from unaffiliated nurseries, specific species selection, and even generates revenue from contracts with other cities in the area.

5. Sacramento, California
    a. City Urban Forestry group partnered with SMUD (Sacramento Municipal Utility District) and the nonprofit Sacramento Tree Foundation to implement the Shade Tree Program. The program included a joint study which modeled 72 different shading scenarios with assigned present benefit values (PVBs). Over 500,000 trees were planted by SMUD, focusing on placing trees where they would have the highest PVB and reduce energy use in buildings.
6. Austin, Texas
    a. Heat Island Containment Policy passed in 2001, with an associated program called "Neighborwoods."
        i. Established by the City, but now administered by the nonprofit TreeFolks. Austin Energy customers get new free trees in the right-of-way, and they are responsible for maintaining them (upfront outreach to garner support is important).
    b. Sapling Days - each fall they give away about 3,000 saplings to residents for planting on private property.
    c. Austin Community Trees Program - Partner with the City and neighborhoods to offer numerous tree species and sizes for planting.
    d. Green Roof Advisory Group (City staff) explored feasibility of green roofs in downtown areas. The Great Streets Program works with private developers to incorporate green space into projects. And when new lane miles are required, 1% of the project's costs must be dedicated to incorporating and caring for trees.
    e. Austin Energy gives the homeowner a new free tree any time they have to remove a tree for utility reasons.
    f. Austin has an Urban Forestry Board (appointed by City Council) to "meet monthly to study, investigate, plan, advise, report, and recommend any action, plan program, or legislation that they determine advisable."

Involving neighborhoods and communities and forging urban forestry partnerships

7. Baltimore, Maryland - TreeBaltimore is a City-led partnership to plant more trees, and every spring and fall they offer free one-gallon trees for homes and businesses.
8. Denver, Colorado - The Park People (nonprofit est 1969) started as a group to raise private funds for park-enhancement projects.
    a. Adopted the grassroots "Denver Digs Trees" program to distribute trees for free citywide. Residents can sign up for a free street tree in the spring, and yard shade trees in the fall. Trees are free or $25 a piece depending on the

neighborhood. The Park People provide planting assistance and residents commit to long-term care of the newly planted trees.

b. The Park People partner with businesses by instituting the Mile High Tree Champions Program, in which businesses host planting days with sponsorship and volunteer labor, while the nonprofit provides the trees, tools, and expertise.
c. The City often partners with sports teams for fundraising.

9. Indianapolis, Indiana
    a. City Urban Forestry group is very involved in development projects and site design/planning for private and Capital Improvement Plans.
    b. Keep Indianapolis Beautiful (KIB, inc. is an affiliate of the Keep America Beautiful, inc) is a non profit partner.
        i. Manages all of Urban Forestry's tree planting projects through the Neighborwoods program. They reach out to Hot Spots identified as needing trees the most and supply trees and expertise to get trees in the ground where possible.
        ii. Day of Service program - local businesses and corporations volunteer to plant trees in public spaces.
    c. Credibility and accountability for programs through the use of GPS tracking systems that catalog each tree planted and its location (via GPS way points) in order to produce accurate maps of plantings for future monitoring and maintenance.
    d. Reconnecting Our Waterways - program that integrates urban forestry and stormwater management needs by identifying riparian corridors where restoration can happen.
10. Atlanta, Georgia
    a. Trees Atlanta (nonprofit est 1985) performs many functions/programs similar to Canopy (tree planting, City contracts, education and outreach, tree walks, etc).
    b. Atlanta Beltline is a project that involves building a 22-mile ring of trails, parks, public transportation, educational signs, etc along an old railroad track that rings the city.
        i. 20-year project to connect 45 neighborhoods through an "integrated approach to transportation, land use, greenspace, and sustainable growth."
        ii. The Beltline Arboretum is a reforestation of a 22-mile beltline corridor through "urban forest rehabilitation and brownfield reclamation.." and features "natural neighborhoods" designed with specific themes. It is an important tool in defragmenting the urban forest to provide wildlife habitat and reducing invasive species' ability to take over and degrade the health of the urban forest.
11. Seattle, Washington
    a. Green Seattle Partnership started in 2004 between the City of Seattle and Forterra (nonprofit)
        i. Established habitat "Treeiage" by breaking down acreage into smaller management areas - a model adopted by many cities to follow.

ii. The Urban Forester credits the successes to the January 1997 issue "Journal of Arboriculture" that outlines 3 elements essential for a sustainable urban forest: 1) healthy forest and other vegetation, 2) community-wide support, and 3)a comprehensive management approach.
    1. Know the science of treeiage - know who is managing and with what resources, and engage the community in the work and advocacy.

b. Seattle Releaf program - City program devised to help achieve the canopy goals of the 2007 Urban Forest Master Plan. Leveraged funding and volunteer hours for accomplish goals.
c. Seattle City Light is Seattle's publicly-owned utility, which works to fund research and restoration, purchases strategic land parcels for habitat protection, and even plants trees to replace what was cleared for utilities.
    i. Partners with SDOT for neighborhood plantings.
    ii. Offers urban landscape tree certificates to residents to offset its tree removals.