City of Burbank, California Municipal Forest Resource Analysis

June, 2008

DAVEY
RESOURCE GROUP
A Division of The Davey Tree Expert Company

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Municipal Forest Resource Analysis

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Executive Summary

Burbank's street trees are a valuable municipal resource and a critical component of the urban infrastructure, as well as an important part of the city's identity and history. The Park, Recreation, and Community Services Department is responsible for the care and management of Burbank's public trees. Currently, tree pruning is done in-house on an as-needed basis or at the request of a resident. Up to 150 new trees are available annually for installation in parkways upon the request of the adjacent property owner. Additionally, the department plants a new tree whenever a tree must be removed.

The City of Burbank is taking a proactive approach to monitoring the community forest and contracted with Davey Resource Group (DRG) in 1999 to conduct a street tree inventory. The inventory is maintained by the urban forestry staff using TreeKeeper® 7.6, an urban forestry management system developed by Davey to provide accurate and dependable inventory data specific to tree characteristics, maintenance performed, and general health.

In October 2007, Burbank contracted with Davey Resource Group to inventory park trees in high use areas. The inventory consisted of all city-managed parks, playgrounds, and the City Public Works Yard, but excluded golf courses as they are not managed by the Department of Parks and Recreation. Only trees that had the potential to affect users of Wildwood Canyon Park were inventoried. Those that exist in the non-maintained areas of the preserve were not included in the inventory at the request of the city. In total, 3,658 trees in 27 separate areas were inventoried.

In March, 2008, The City of Burbank commissioned DRG to conduct an analysis of the city's public tree resource, combining the results of the both the street and park tree inventories with benefit-cost modeling data to produce quantified information on the resource's structure, function, and value.

Tree Resource Structure

Burbank's street and park tree inventory includes 32,077 publicly-managed trees. A structural analysis is the first step towards understanding the benefits that these trees provide and their management needs. After examining species composition, diversity, age distribution, condition, canopy coverage, and replacement value, DRG determined that the following information characterizes Burbank's tree resource:

- There are over 180 distinct species growing in the parks and along the streets of Burbank; the predominant street tree species are camphor, crapemyrtle, sweetgum, southern magnolia, and Callery pear.
- The overall age structure of Burbank's public tree population is approaching ideal, with an adequate number of young trees in relationship to the overall population. Additional annual planting is encouraged in order to idealize optimum age structure of valuable species and to preserve an ideal overall age structure and maintain the flow of benefits provided by Burbank's public trees.

- The majority of Burbank's trees are reportedly in good condition. Maintaining these existing trees as long as possible will increase their useful lifespan and maintain a flow of benefits.

Replacement of Burbank's 32,077 park and street trees with trees of similar size, species, and condition would cost approximately $162 million.

- Burbank's street tree canopy cover is estimated at 331 acres, or 3% of the total land area and 19.8% of the total street and sidewalk area within the city.
- Replacement of Burbank's 32,077 park and street trees with trees of similar size, species, and condition would cost approximately $162 million.
- Burbank's current stocking level for street trees is 46.5%. Based on Burbank's estimated 300 linear miles of streets, 33,900 additional trees would need to be planted to reach 100% stocking.

Tree Resource Benefits

Annually, Burbank's public trees provide cumulative benefits to the community valued at $134 per tree, for a gross total value of appoximately $4.3 million per year. The city's park and street trees are providing the following substantial annual benefits:

- Street and park trees reduce electricity and natural gas use in Burbank from both shading and climate effects equal to $325,741, for a citywide average of $10.15 per tree.
- The street and park trees in Burbank reduce atmospheric CO_2 by a value of $37,942 per year, for a net benefit per tree of $1.18.
- The net air quality improvement provided by the park and street tree population from the removal and avoidance of air pollutants is valued at $687,571 per year for an average net benefit per tree of $21.44.
- Burbank's park and street trees intercept 22.4 million gallons of stormwater annually for a total value of this benefit to the city is $41,081 per year for an average value of $1.28 per tree.
- The estimated total annual benefit of Burbank's street and park trees that is associated with property value increases, aesthetics, and other less tangible improvements is $3.2 million for an average of $99.59 per tree.
- When the city's annual tree-related expenditures are considered ($1.8 million), the net annual benefit (benefits minus costs) to the city is $2.4 million. The average net benefit for an individual street tree in Burbank is $76 per year. **Burbank receives $2.33 in benefits for every $1 that is spent on its municipal forestry program.**

Tree Resource Management

Burbank's street and park tree population is a dynamic resource that is worth continued investment to ensure its full potential. **The community forest is one of the few assets that has the potential to increase in value with time and proper management.** Trees improve the quality of life in the community and help to lessen the environmental impact of urbanization. This critical resource is, however, vulnerable to a host of stressors. Sound management practices are required to sustain the flow of benefits. Achieving resource sustainability requires that Burbank:

Burbank receives $2.33 in benefits for every $1 spent on municipal forestry.

- Sustain the benefits of the existing tree resource through comprehensive tree maintenance, including new tree establishment and cyclical pruning.
- Develop a replacement plan for the city's most mature trees (and top benefit producers) to replace them with trees of similar stature gradually before they must be removed.
- Implement a citywide tree planting strategy to increase overall tree numbers, increase canopy coverage, ensure a stable population, and maintain the flow of benefits over time. Focus on large-stature trees where conditions are sustainable to maximize benefits.
- Maintain an appropriate age distribution by planting new trees to improve long-term resource sustainability.
- Select species and match them to existing site conditions to avoid conflicts with infrastructure.
- Strengthen the city's network of partners and urban forest managers to collaborate towards the common goal of an improved, more functional, and sustainable street tree resource.

The value of Burbank's street and park tree resource should increase as existing trees mature and new trees are planted. As the resource grows, continued investment in management is critical to ensuring that residents will continue receiving a high return on investment in the future. It is not as simple as planting more trees to increase canopy cover and benefits. Planning and funding for care and management must complement planting efforts in order to ensure the long term success and health of new plantings. Existing trees must also be maintained and protected since the greatest benefits will accrue from continued growth of the existing canopy. Burbank's trees are a dynamic resource requiring constant care to maximize and sustain production of benefits into the future. However, Burbank can take pride in knowing that street trees do improve the quality of life in the city and, perhaps just as importantly, trees are well worth the investment.

Chapter 1: Introduction

Founded in 1887, the City of Burbank is located in the eastern part of the San Fernando Valley in Los Angeles County, California. Nestled against the Verdugo mountains, Burbank occupies an area of approximately 17.2 square miles and is home to more than 100,000 residents. Recognized today as the media capital of the world, Burbank's early growth was dependent upon the industries of trucking and aviation, as well as the entertainment and movie business.

The citizens of Burbank enjoy a high quality of life and the community takes great pride in programs aimed at conservation and sustainability—playing host to the Regional Intermodal Transportation Center (RITC), irrigating with recycled water, and boasting a nationally acclaimed recycling program (the Burbank Recycle Center) which handles up to 5,000 tons of recyclables every month.

Not surprisingly, Burbank struggles with air quality issues. The community is home to the Bob Hope Airport, which annually serves five million travelers. The heavily traveled Golden State Freeway bisects the community and the Ventura Freeway runs just to the south. Additionally, Burbank's air is negatively impacted by the Port of Los Angeles (which is responsible for 25% of the region's pollution). In addition, many experts are predicting catestrophic effects from climate change, including a rising heat index and increased drought conditions in many areas of the world.

Demonstrating a proactive attitutude, Burbank's City Council approved a resolution in January 2008 in support of the United Nations Urban Environmental Accords, a series of goals and action items adopted at the local level aimed at achieving urban sustainability, as well as promoting healthy economies, advancing social equity, and protecting the world's ecosystem. City Council also adopted a Sustainability Action Plan aimed at implementing these goals on a local level. Additionally, Burbank has joined over 500 cities nationwide in striving to reduce global warming pollution by committing to the U. S. Mayors Climate Protection Agreement.

Research has demonstrated that healthy city trees can improve the local environment and lessen impacts resulting from urbanization and industry. Urban trees slow and reduce stormwater runoff, helping to protect our waterways from excess pollutants and particulate matter. Trees improve air quality by manufacturing oxygen and absorbing carbon dioxide (CO_2), sulfer dioxide (SO_2) as well as particulate matter. Urban trees reduce energy consumption by shading structures from solar energy and reducing the overall rise in temperature causesd by urban heat island effects. Urban trees also provide critical habitat to wildlife and promote a connection to the natural world.

Burbank's 30,077 public trees play a prominent role in the environmental benefits afforded to the community.

In addition to these direct

environmental improvements, healthy public trees increase the overall attractiveness of a community and have been shown to increase the value of local real estate and promote shopping, retail sales, and tourism. Trees promote a more livable community, fostering psychological health and providing residents with a greater sense of place. Community trees, both public and private, soften the urban hardscape, providing a green sanctuary and making Burbank a more enjoyable place to live, work, and play. The city's 30,077 street and park trees play a prominent role in the benefits afforded to the community and the citizens rely on the City of Burbank to maintain this resource.

Recognizing that stewardship of the urban forest is critical to sustainability and to preserving a healthy urban climate, the City of Burbank contracted with Davey Resource Group (DRG) to produce a municipal forest resource analysis and report based on the current tree inventory database. This report focuses on street and park trees, the city's most readily quantifiable resource in terms of numbers and benefits provided. The study incorporated the city's current street tree inventory into i–Tree's Street Tree Resource Analysis Tool for Urban Forest Managers (STRATUM v3.2) in order to establish baseline information on the value that public trees provide to the community. Although STRATUM was developed specifically for street trees, the data from park trees can be extrapolated and incorporated into an overall municipal forest analysis. This report, which is unique to Burbank, effectively quantifies the value of the community's public trees in regards to actual benefits derived from the tree resource. In addition, the report provides a baseline analysis which can be used when developing and updating an urban forest management plan, determining where best to focus available resources and setting benchmarks for measuring progress.

The purpose of the municipal forest resource analysis and report is to provide information on the structure, function, and value of the street tree resource so that managers and citizens alike can make informed decisions about budgetary support and management priorities. This report is intended to provide the following information:

- A description of the current structure of Burbank's street and park tree resource and an established benchmark for future management decisions.
- Current, detailed management expenditures for Burbank's publicly-managed trees and critical baseline information for evaluating program efficiency.
- A quantified value of the environmental benefits provided by Burbank's street and park trees, as well as illustrating the relevance and relationship of the resource to local quality of life issues, such as air quality and environmental health, economic development, and psychological health.
- Quantified data that may be used by resource managers in the pursuit of alternative funding sources and collaborative relationships with utility purveyors, non-profit organizations, air quality districts, federal and state agencies, legislative initiatives, or local assessment fees.
- Benchmark data which can be used in the development of a long term community forest management plan.

The city's street trees were inventoried in 1999 and the park trees in 2007 by DRG utilizing proprietory Work Planning Software. During the park inventory, only trees that have the potential to impact the users of Burbank's Wildwood Canyon Park were inventoried. Trees in the far reaches of the park, as well as trees located in municipal golf courses, were not included in the inventory and are not represented in this analysis. Therefore, the full extent and benefit of Burbank's municipal forest is understated.

Chapter 2: Burbank's Municipal Tree Resource

Population Composition

Burbank's street and park tree population is dominated by broadleaf trees (91% of the total). Broadleaf trees typically have larger canopies than coniferous street trees of the same size and, because most of the benefits provided by trees are related to leaf surface area, broadleaf trees generally provide the highest level of benefit. Larger-growing broadleaf trees provide greater benefits than smaller-growing broadleafs. Broadleaf evergreen trees make up 52% of the population with 3,009 (9%) large-growing broadleaf evergreens, 7,907 (26%) medium-growing broadleaf evergreens, and 5,235 (17%) small-growing broadleaf evergreen trees. Broadleaf deciduous trees make up 39% of the population with 3,646 (11%) large-growing broadleaf deciduous trees, 4,451 (14%) medium-growing broadleaf deciduous trees, and 4,647 (14%) small-growing broadleaf decidous trees. The remainder of the population is comprised of 1,912 (6%) conifers and 1,271 (3%) palms. Additional detailed information on Burbank's street tree resource may be found in Appendices B and C.

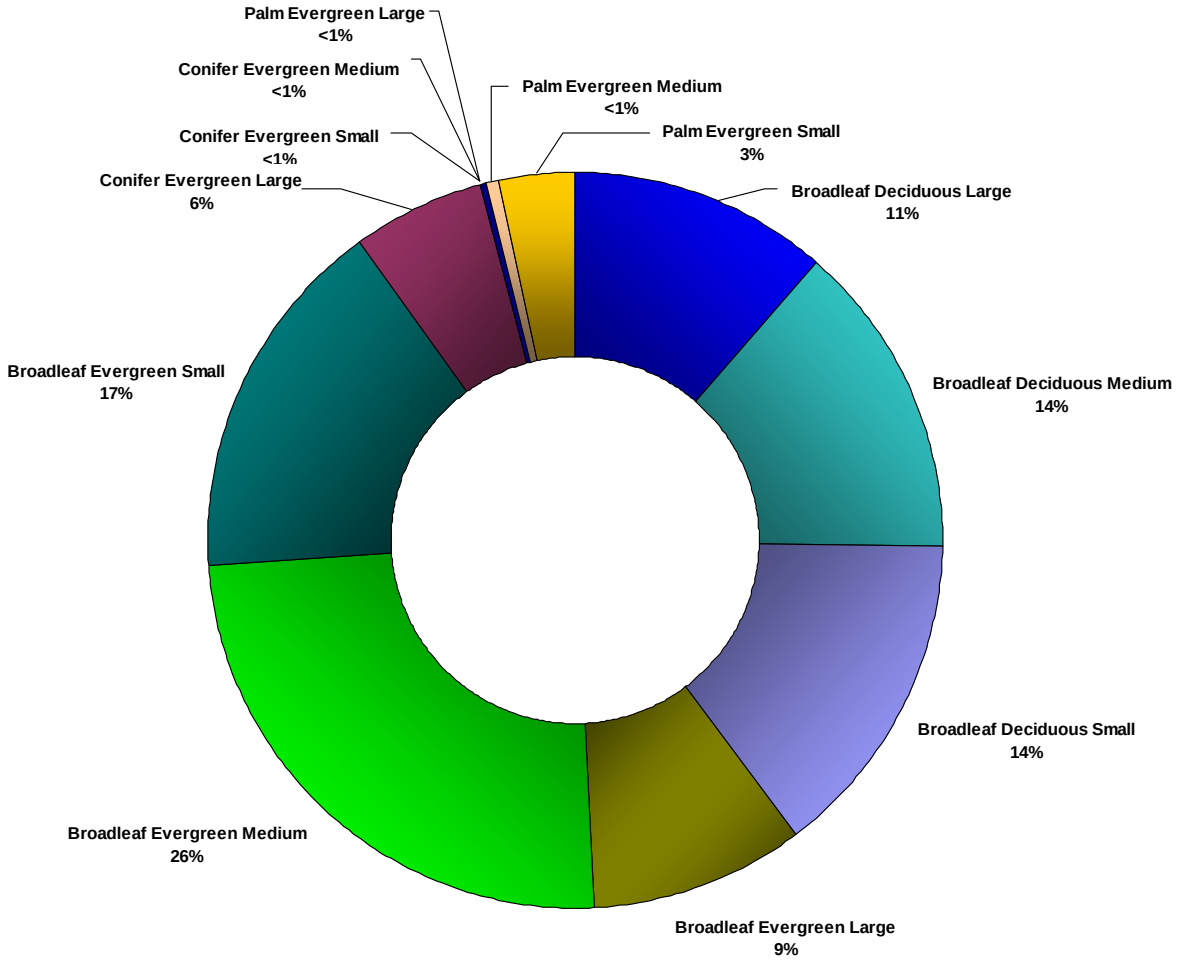
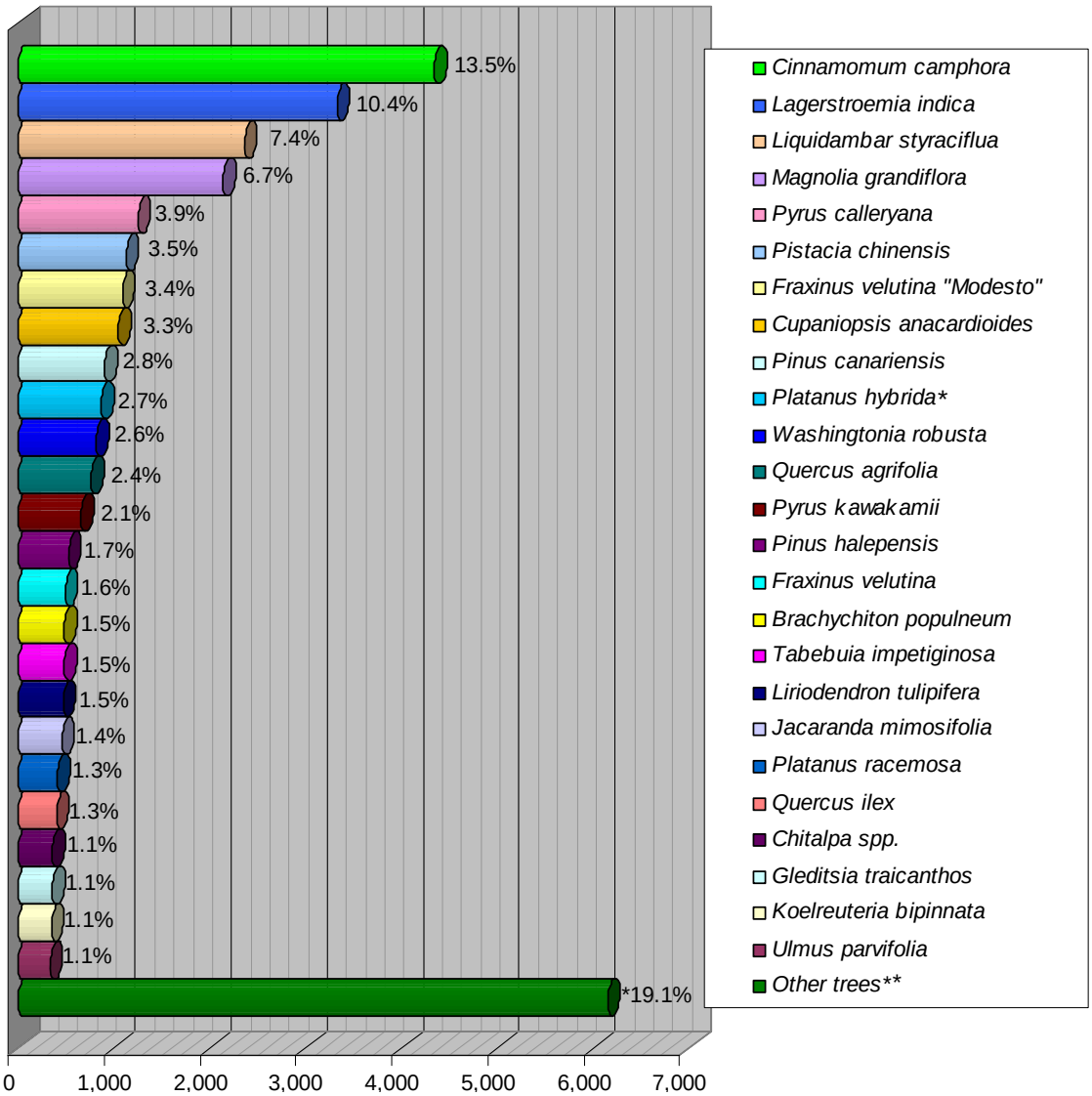


Figure 1. Population Compostition of Burbank's Public Trees.

Species Richness and Composition

The public tree population includes a mix of more than 180 species— nearly three and a half times more than that of the mean of 53 species reported by McPherson and Rowntree (1989) in their nationwide survey of street tree populations in 22 U. S. cities.

The top four occurring species comprise 38% of the total population (Figure 2 and Table 1, see also Appendix B). The predominant street tree species are camphor (*Cinnamomum camphora*, 13.5%), common crapemyrtle (*Lagerstroemia indica*, 10.4%), sweetgum (*Liquidambar styraciflua*, 7.4%), and southern magnolia (*Magnolia gradiflora*, 6.7%). The percentage of camphor and crapemyrtle exceed the widely accepted rule that no single species should represent more than 10% of the total population and no single genus more than 20% (Clark and others, 1997), demonstrating a small need of further diversification (Appendix C). The abundance of crapemyrtle is indicative of the fact that it is the City Tree of Burbank.



**Platanus hybrida, a.k.a. Platanus acerifolia (USDA Plant Database and STRATUM).*
***Other trees = 19.1% of the population is comprised of species which represent less then 1% of the total population.*

Figure 2. Species Population Summary of Burbank's Public Trees.

Dominance of any single species or genus in a population can have catastrophic consequences in the event of storms, drought, disease, pests, or other stressors which can effect an urban forest and the flow of benefits and costs over time. Unfortunately, many urban forest managers have become well aware of the implications of a heavily skewed population through hard experience. Historical examples of Dutch elm disease and the present threat of pests, such as emerald ash borer (*Agrilus planipennis* Fairmaire) and Asian Longhorned beetle (*Anoplophora glabripennis*), as well as Sudden Oak Death (SOD) (*Phytophthora ramorum*) highlight the importance of a balanced distribution of species and genera.

Table 1. Most Frequently Occurring Public Tree Species by DBH Class and Tree Type[1].

Species	DBH Class (in)									Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	
Broadleaf Deciduous Large (BDL)										
Fraxinus velutina "Modesto"	4	13	312	416	253	72	22	1	0	1,093
Platanus hybrida[2]	28	49	80	225	273	156	47	16	0	874
Liriodendron tulipifera	180	118	125	54	1	0	0	0	0	478
Platanus racemosa	13	3	57	98	86	92	54	11	1	415
Gleditsia traicanthos	27	95	212	26	0	1	0	0	0	361
BDL OTHER	26	21	52	73	94	78	61	12	8	425
Total	**278**	**299**	**838**	**892**	**707**	**399**	**184**	**40**	**9**	**3,646**
Broadleaf Deciduous Medium (BDM)										
Liquidambar styraciflua	21	76	434	1,039	603	174	17	1	0	2,365
Pistacia chinensis	461	380	279	11	0	0	1	0	0	1,132
Koelreuteria bipinnata	82	51	122	91	5	0	0	0	0	351
BDM OTHER	153	169	143	75	36	14	8	4	1	603
Total	**717**	**676**	**978**	**1,216**	**644**	**188**	**26**	**5**	**1**	**4,451**
Broadleaf Deciduous Small (BDS)										
Lagerstroemia indica	1,114	1,548	656	8	0	1	3	0	0	3,330
Jacaranda mimosifolia	50	50	120	146	84	10	3	0	0	463
Chitalpa spp.	113	147	104	0	0	0	0	0	0	364
BDS OTHER	230	135	100	16	7	1	1	0	0	490
Total	**1,507**	**1,880**	**980**	**170**	**91**	**12**	**7**	**0**	**0**	**4,647**
Broadleaf Evergreen Large (BEL)										
Quercus agrifolia	48	38	88	136	220	149	78	14	1	772
Fraxinus velutina	1	1	94	200	128	58	14	1	0	497
Quercus ilex	7	24	124	171	61	13	4	0	0	404
Ulmus parvifolia	6	21	41	117	139	12	3	0	0	339
BEL OTHER	63	98	263	251	157	97	41	18	9	997
Total	**125**	**182**	**610**	**875**	**705**	**329**	**140**	**33**	**10**	**3,009**

[1] Species listed represent >1% of the total population. All other species are included in "Other."

[2] Platanus hybrida, a.k.a. Platanus acerifolia (USDA Plant Database and STRATUM).

Broadleaf Evergreen Medium (BEM)										
Cinnamomum camphora	46	60	512	1,336	1,373	613	293	93	18	4,344
Magnolia grandiflora	88	172	798	797	226	54	7	1	0	2,143
Brachychiton populneum	6	12	207	208	43	15	0	0	0	491
BEM OTHER	79	95	196	239	191	75	35	13	6	929
Total	**219**	**339**	**1,713**	**2,580**	**1,833**	**757**	**335**	**107**	**24**	**7,907**
Broadleaf Evergreen Small (BES)										
Pyrus calleryana	428	359	374	89	5	0	0	0	0	1,255
Cupaniopsis anacardioides	161	199	453	223	13	1	0	0	0	1,050
Pyrus kawakamii	79	169	327	87	0	0	0	0	0	662
Tabebuia impetiginosa	236	110	127	10	0	0	0	0	0	483
BES OTHER	565	410	580	175	38	15	1	0	0	1,784
Total	**1,469**	**1,247**	**1,861**	**584**	**56**	**16**	**1**	**0**	**0**	**5,234**
Conifer Evergreen Large (CEL)										
Pinus canariensis	37	44	161	287	178	160	40	3	0	910
Pinus halepensis	6	8	85	139	93	73	81	35	13	533
CEL OTHER	23	38	97	71	88	62	24	8	8	419
Total	**66**	**90**	**343**	**497**	**359**	**295**	**145**	**46**	**21**	**1,862**
Conifer Evergreen Medium (CEM)										
CEM OTHER	0	0	0	5	0	0	0	0	0	5
Total	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**5**
Conifer Evergreen Small (CES)										
CES OTHER	7	10	20	7	1	0	0	0	0	45
Total	**7**	**10**	**20**	**7**	**1**	**0**	**0**	**0**	**0**	**45**
Palm Evergreen Large (PEL)										
PEL OTHER	0	1	0	1	13	30	16	2	0	63
Total	**0**	**1**	**0**	**1**	**13**	**30**	**16**	**2**	**0**	**63**
Palm Evergreen Medium (PEM)										
PEM OTHER	1	11	7	103	19	0	0	0	0	141
Total	**1**	**11**	**7**	**103**	**19**	**0**	**0**	**0**	**0**	**141**
Palm Evergreen Small (PES)										
Washingtonia robusta	3	4	43	728	39	1	0	0	0	818
PES OTHER	4	6	150	53	4	2	30	0	0	249
Total	**7**	**10**	**193**	**781**	**43**	**3**	**30**	**0**	**0**	**1,067**
Citywide Total	**4,396**	**4,745**	**7,543**	**7,711**	**4,471**	**2,029**	**884**	**233**	**65**	**32,077**

Species Importance

To quantify the significance of any one particular species found in Burbank's public tree population, an *importance value* (IV) is assigned to each species in the tree inventory. Importance values are particularly meaningful to urban forest managers because they indicate a community's reliance on the functional capacity of particular species. STRATUM calculates IV based on the mean of three important values: percentage of total population, percentage of total leaf area, and percentage of total canopy cover. Importance value goes beyond tree numbers alone to suggest reliance on different species based on the benefits they provide.

The IV can range from zero (which implies no reliance) to 100 (which suggests total reliance). No single species should dominate the species composition in the city's street tree population. Because IV goes beyond population numbers alone, it can help managers to better understand the resulting loss of benefits from a catastrophic loss of any one species. When IVs are evenly dispersed among the ten to 15 most abundant species, the risk of significant reductions to benefits is reduced. Of course, suitability of the dominant species is an important consideration. Planting short-lived or poorly adapted species can result in short rotations and increased long-term management costs.

The 25 most abundant street tree species in Burbank's public tree inventory represent 80.8% of the total population, 84.7% of the total leaf area, and 84.7% of the total canopy cover from street trees for a combined IV of 83.4 (Table 2). Of these species, Burbank relies most on the functional capacity of camphor (*Cinnamomum camphora*, IV=20.0), sweetgum (*Liquidambar styraciflua*, IV=7.4), and southern magnolia (*Magnolia grandiflora*, IV=7.7). However, both Modesto ash (*Fraxinus velutina* "Modesto", IV=6.7), which comprises 3.4% of the total population, and London planetree (*Platanus hybrida*, IV=6.2), which comprises only 2.7% of the total population, are each more important in terms of capacity to produce benefits than the second most common tree species, common crapemyrtle (*Lagerstroemia indica*, IV=5.3), which comprises 10.4% of the total population. This is attributable to each species' relative maturity, greater size, and greater leaf area. London planetree (*Platanus hybrida*), camphor (*Cinnamomum camphora*) and Canary Island pines (*Pinus canariensis*) are among the largest street trees in Burbank, having a significant percentage of individuals (in relation to their specific population) in mature size classes (>24 inches DBH), 25%, 23%, and 22%, respectively. Burbank's California sycamore (*Platanus racemosa*), accounting for only 1% of the population, have an IV of only 3 but are are providing the greatest per tree functional capacity to provide benefits, behind London planetrees (*Platanus hybrida*, IV=6.2), compared to their representation in the population. Alleppo pines (*Pinus halepensis*) are also performing at a higher functional capacity with a population at 1.7% and an IV of 3.3

Due to their relatively small leaf area and canopy coverage, immature trees and small-stature trees tend to have lower importance values than their population numbers might suggest. In Burbank, tulip tree (*Liriodendron tulipifera*) represents less than 1.5% of the total population and has an IV of only 1.2. An analysis of tree size shows that 88.5% of the large-growing tulip trees are immature (<12 inches DBH). Common crapemyrtle, a small-stature tree, represent 10.4% of the total population but have an IV of only 5.3. However, tulip trees and and other medium- and large-growing species have the potential to increase their importance as they mature.

Table 2. Importance Values (IV) for Burbank's Most Abundant Street Trees.

Species	Number of Trees	% of Total Trees	Leaf Area (ft2)	% of Total Leaf Area	Canopy Cover (ft2)	% of Total Canopy Cover	Importance Value
Cinnamomum camphora	4,344	13.54	9,724,340.00	18.82	4,477,076.00	27.75	**20.04**
Lagerstroemia indica	3,330	10.38	951,023.50	1.84	583,702.44	3.62	**5.28**
Liquidambar styraciflua	2,365	7.37	4,423,018.00	8.56	1,010,462.88	6.26	**7.40**
Magnolia grandiflora	2,143	6.68	3,031,163.50	5.87	1,238,379.00	7.68	**6.74**
Pyrus calleryana	1,255	3.91	358,710.78	0.69	144,081.48	0.89	**1.83**
Pistacia chinensis	1,132	3.53	449,075.13	0.87	148,471.30	0.92	**1.77**
Fraxinus velutina "Modesto"	1,093	3.41	5,145,938.00	9.96	1,072,688.25	6.65	**6.67**
Cupaniopsis anacardioides	1,050	3.27	658,859.13	1.28	355,708.84	2.20	**2.25**
Pinus canariensis	910	2.84	3,040,920.25	5.89	407,912.53	2.53	**3.75**
Platanus hybrida	874	2.72	5,083,637.50	9.84	987,185.38	6.12	**6.23**
Washingtonia robusta	818	2.55	170,470.72	0.33	85,525.99	0.53	**1.14**
Quercus agrifolia	772	2.41	1,329,991.25	2.57	475,550.00	2.95	**2.64**
Pyrus kawakamii	662	2.06	273,792.47	0.53	108,402.18	0.67	**1.09**
Pinus halepensis	533	1.66	2,500,989.00	4.84	552,457.38	3.42	**3.31**
Fraxinus velutina	497	1.55	659,092.69	1.28	260,085.89	1.61	**1.48**
Brachychiton populneum	491	1.53	593,827.31	1.15	301,026.97	1.87	**1.52**
Tabebuia impetiginosa	483	1.51	111,490.94	0.22	44,493.77	0.28	**0.67**
Liriodendron tulipifera	478	1.49	607,173.13	1.18	136,146.22	0.84	**1.17**
Jacaranda mimosifolia	463	1.44	304,649.66	0.59	169,899.34	1.05	**1.03**
Platanus racemosa	415	1.29	2,480,017.75	4.80	481,020.34	2.98	**3.03**
Quercus ilex	404	1.26	378,469.13	0.73	155,391.73	0.96	**0.99**
Chitalpa spp.	364	1.13	123,161.47	0.24	73,507.63	0.46	**0.61**
Gleditsia traicanthos	361	1.13	601,830.50	1.16	142,528.16	0.88	**1.06**
Koelreuteria bipinnata	351	1.09	343,903.06	0.67	89,941.41	0.56	**0.77**
Ulmus parvifolia	339	1.06	407,831.81	0.79	166,338.22	1.03	**0.96**
Other trees*	6,150	19.17	7,906,858.00	15.31	2,467,013.25	15.29	**16.59**
Total	**32,077**	**100.00**	**51,660,212.00**	**100.00**	**16,134,996.00**	**100.00**	**100.00**

Stocking Level

Although the inventory on which this study is based does not include complete information on vacant sites for the determination of stocking level, 8,095 vacant sites were identified. Additionally, stocking level can be estimated based on total street miles and the total number of existing street trees (Gable, 2006). Burbank has 29,420 street trees and 300 linear miles of street for an average of 98 trees per street mile. Theoretically, a given street would have room for a tree every 50 feet along both sides of the street, or 211 trees per mile. This suggests that in order to reach full stocking potential of 63,300 trees, an additional 33,900 street trees should be planted in Burbank. Although the actual number of street tree planting sites may be significantly fewer due to inadequate planting spaces, proximity of private trees, and utility conflicts, by this measure Burbank's street tree stocking level is 46.5%. Comparitively, the mean stocking level for 22 U. S. cities is 38.4% (McPherson and Rowntree, 1989).

Calculating the number of street trees per capita is another important measure of tree stocking. Assuming a human population of 100,100 (City of Burbank web site), Burbank's number of street trees per capita is 0.29, approximately one tree for every 3.4 people. Comparitively, the mean for 22 U. S. cities is approximately one tree for every 2.7 people (McPherson and Rowntree, 1989). It would take an additional 7,654 newly planted trees to reach this reported benchmark.

While comparing Burbank's stocking level with the mean for 22 U. S. cities (McPherson and Rowntree, 1989) is a helpful measurement for gauging how the community stands in relationship to others, it must be recognized that the mean is only an average. In order to receive the maximum benefits available from an urban forest, Burbank is encouraged to exceed the mean and utilize available planting space to the fullest potential.

Relative Age Distribution

The distribution of individual tree ages within a tree population influences present and future costs as well as the flow of benefits. An unevenly aged population allows managers to allocate annual maintenance costs uniformly over many years and assures continuity in overall tree canopy coverage. A desirable distribution has a high proportion of young trees to offset establishment and age-related mortality as the percentage of older trees declines with age (Richards, 1982/83). This ideal uneven distribution suggests the largest fraction of trees (40% of the total) should be young, with diameters less than 8 inches, while only 10% should be in the large diameter classes (>24 inches).

Burbank's overall age distribution is comparible to the ideal, with 28% young trees (<6 inches DBH), 24% established trees (6–12 inches DBH), 38% maturing trees (12–24 inches DBH), and 10% mature trees (>24 inches DBH) (Figure 3). Given that the current stocking level is estimated at 46.5 %, Burbank should continue to plant new trees annually with the goal of increased stocking and species diversification, and to ensure that as the current tree population matures the relative age distribution will continue to be optimized.

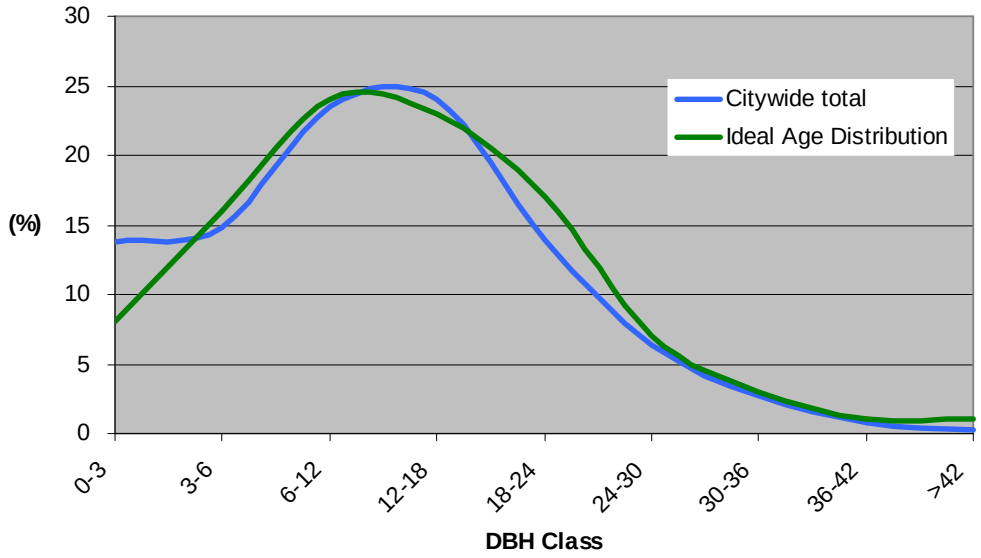


Figure 3. Burbank's Relative Age Distribution Versus Ideal Distribution.

An uneven age distribution heavily weighted in younger trees, whether occurring in the total population or a single species, is an age structure that provides a consistant flow of benefits, even if major losses in canopy or species occur.

A desirable species distribution has a high proportion of young trees to offset establishment and age-related mortality.

Of Burbank's top ten public tree species (Figure 4), common crapemyrtle (*Lagerstroemia indica*, 79.9%), Chinese pistache (*Pistachia chinensis*, 74.3%), and Callery pear (*Pyrus calleriensis*, 62.7%) are heavily represented in the small size class (<6 inches DBH), indicating that recent plantings have concentrated on these species. London planetree (*Platanus hybrida*, 25.1%), camphor (*Cinnamomum camphora*, 23.4%), and Canary Island pine (*Pinus canariensis*, 22.3%) dominate the larger size (>24 inches DBH), but have less than adequate representation in the smaller size classes (0–6 inches DBH). As these species begin to senesce, their maintenance needs become more frequent and, without new plantings, there will not be sufficient replacement stock in place to help stabilize the functional capacity of these large-stature trees. The majority of Modesto ash (*Fraxinus velutina* "Modesto", 89.8%), sweetgum (*Liquidamber styraciflua*, 87.8%), and southern magnolia (*Magnolia grandiflora*, 85%) are found in the middle size classes (6–24 inches DBH).

For the most part, these medium- and large-growing species have inadequate representation in both the smaller size classes and the larger size classes. Burbank's most abundant street tree, camphor (*Cinnamomum camphora*) has less than 3% of its total population in the 0 to 6-inch DBH class. Based on these trends and a current stocking level of 46.5%, Burbank should consider increasing new plantings of specific large-statured species based on performance and and benefits demonstrated in this analysis.

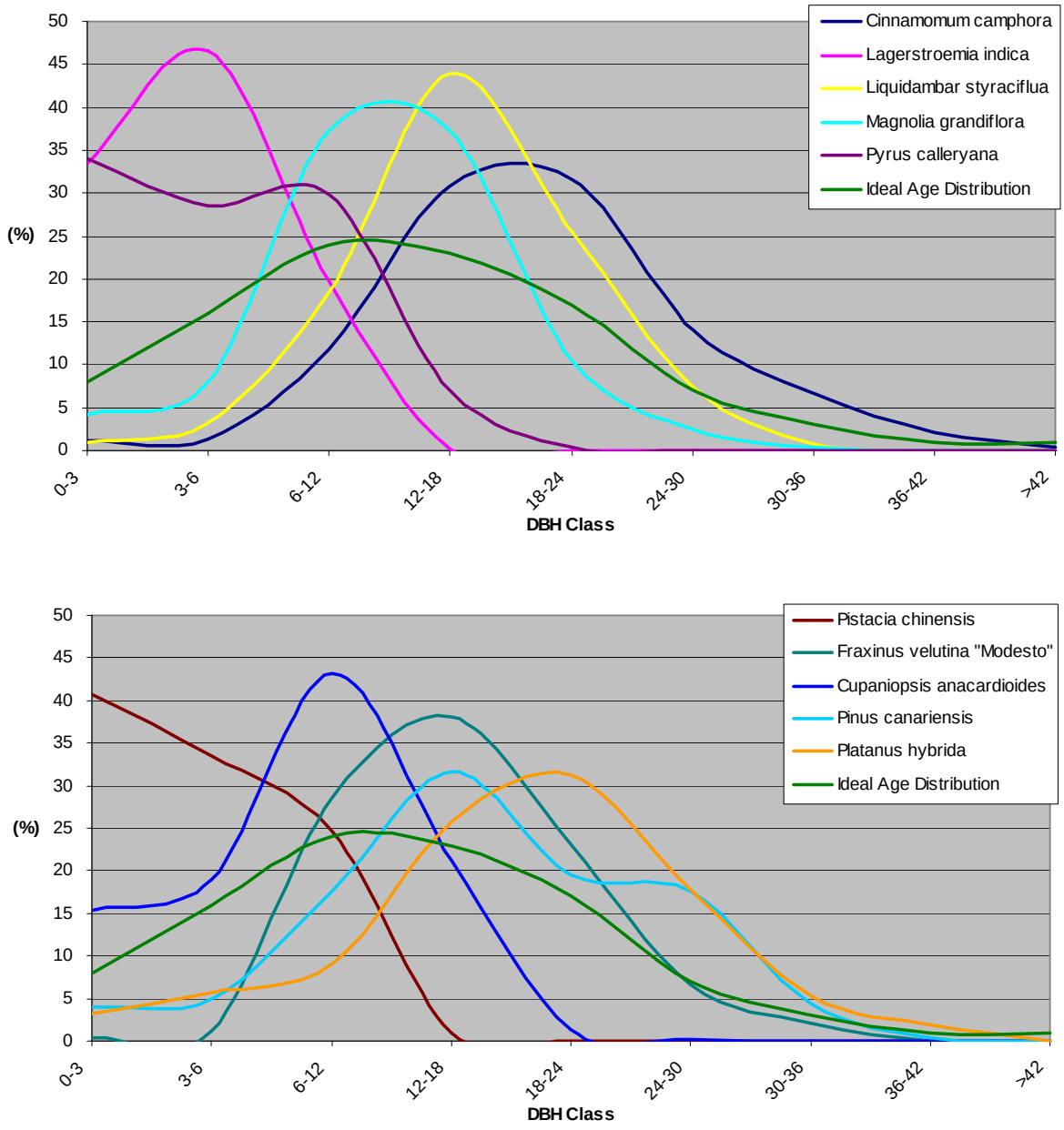


Figure 4. Relative Age Distribution of Burbank's Top Ten Public Trees.

Tree Condition and Relative Performance

Tree condition is an indication of how well trees are managed and how well they perform in a given site-specific condition (Figure 5). When trees are performing at their peak, as are the 65% of trees classified as good, the benefits they provide are maximized. Burbank's inventory classifies 32% of the trees in fair condition, which may be an indication of inadequate maintenance and/or poorly sited species. Approximately 3% of Burbank's public tree resource is in poor condition, with less than 1% of the total population either dead or critical. The goal for critical and dead trees should be zero.

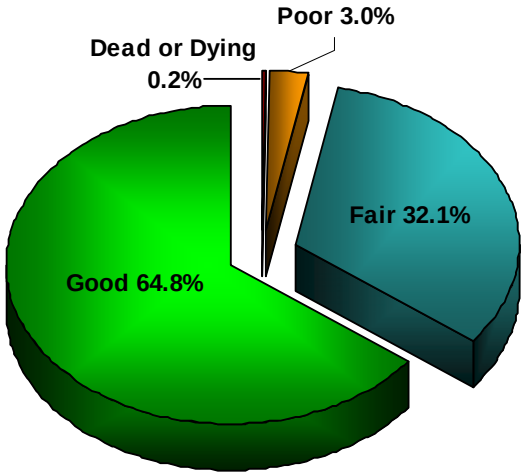


Figure 5. Condition Distribution for Burbank's Tree Population (Foliage).

The *relative performance index* (RPI) is one way to further analyze the condition and suitability of specific urban tree species. The RPI provides an urban forest manager with a detailed perspective on how one species' performance compares to that of another. The index compares the condition rating assigned to each tree and relates that condition to the inventoried tree population as a whole. The RPI is calculated by taking the percentage of each species in good condition and dividing it by the percentage of the total population that is in good condition. An RPI value of 1.0 or better indicates that the species is performing well when compared to other species (i.e., its percentage of good trees is equal to or better than that of the entire population). An RPI value below 1.0 indicate that the species is not performing well compared to the rest of the population.

Among the 25 most abundant street tree species in Burbank, 17 have a RPI greater than 1.0 (Table 3). Of these, Mexican palm (*Washingtonia robusta*, RPI-1.15), Chinese pistache (*Pistachia chinensis*, RPI-1.12), chitalpa (*Chitalpa spp*., RPI-1.12), Chinese flame tree (*Koelreuteria bipinnata*, RPI-1.10) and Canary island pine (*Pinus canariensis*, RPI-1.10) are performing the best. Modesto ash (*Fraxinus velutina* "Modesto", RPI-0.79), camphor (*Cinnamomum camphora*, RPI-0.90), velvet ash (*Fraxinus velutina*, RPI-0.92) and jacaranda (*Jacaranda mimosifolia*, RPI-0.93) are each performing below average.

Both London planetree and Canary Island pine are proven performers in Burbank and are deserving of increased consideration as street trees.

London planetree (*Platanus hybrida*, RPI-1.06), Canary island pine (*Pinus canariensis*, RPI-1.10), sweetgum (*Liquidambar styraciflua*, RPI-0.95), and camphor (*Cinnamomum camphora*, RPI-0.90) are the species which come close to the ideal age distribution (Figure 3), an indicator that their RPI is a true performance measure. With such strong RPI value, both London planetree and Canary island pine are proven performers in Burbank and deserving of increased consideration as street trees. Conversely, Burbank's most important street trees species, camphor, has a fairly low RPI value of 0.90, demonstrating a rather poor performance in relation to most other species in the population.

Table 3. Relative Performance Index (RPI) for Burbank's Most Abundant Street Trees.

Species	Dead or Dying	Poor	Fair	Good	RPI	# of Total Trees	% of Total Population
Cinnamomum camphora	0.02	4.60	55.00	40.38	**0.90**	4,344	13.54
Lagerstroemia indica	0.57	2.88	23.09	73.45	**1.03**	3,330	10.38
Liquidambar styraciflua	0.00	1.27	49.96	48.77	**0.95**	2,364	7.37
Magnolia grandiflora	0.05	4.99	42.60	52.36	**0.95**	2,143	6.68
Pyrus calleryana	0.40	0.64	12.67	86.29	**1.09**	1,255	3.91
Pistacia chinensis	0.18	0.18	6.71	92.93	**1.12**	1,132	3.53
Fraxinus velutina "Modesto"	0.00	7.41	78.96	13.63	**0.79**	1,093	3.41
Cupaniopsis anacardioides	0.00	3.05	34.57	62.38	**0.99**	1,050	3.27
Pinus canariensis	0.22	0.22	11.43	88.13	**1.10**	910	2.84
Platanus hybrida	0.11	2.06	19.34	78.49	**1.06**	874	2.72
Washingtonia robusta	0.00	0.12	0.49	99.39	**1.15**	818	2.55
Quercus agrifolia	0.65	1.68	19.82	77.85	**1.05**	772	2.41
Pyrus kawakamii	0.15	1.36	33.23	65.26	**1.01**	662	2.06
Pinus halepensis	1.88	1.88	16.32	79.92	**1.05**	533	1.66
Fraxinus velutina	0.00	4.23	49.90	45.88	**0.92**	497	1.55
Brachychiton populneum	0.00	1.43	37.07	61.51	**1.00**	491	1.53
Tabebuia impetiginosa	0.00	1.24	13.66	85.09	**1.09**	483	1.51
Liriodendron tulipifera	0.21	1.05	15.90	82.85	**1.08**	478	1.49
Jacaranda mimosifolia	0.22	5.40	45.79	48.60	**0.93**	463	1.44
Platanus racemosa	0.00	3.61	14.70	81.69	**1.06**	415	1.29
Quercus ilex	0.00	3.47	34.65	61.88	**0.99**	404	1.26
Chitalpa spp.	0.27	0.27	7.14	92.31	**1.12**	364	1.13
Gleditsia traicanthos	0.00	0.55	33.24	66.20	**1.02**	361	1.13
Koelreuteria bipinnata	0.00	0.00	12.54	87.46	**1.10**	351	1.09
Ulmus parvifolia	0.00	0.29	32.74	66.96	**1.02**	339	1.06
Citywide total	**0.22**	**2.96**	**32.07**	**64.75**	**1.00**	**32,077**	**100.00**

The RPI can be a useful tool for urban forestry managers. For example, if a city has been planting two new species in their urban forest, RPI can be utilized to compare the two. If RPI indicates that one is performing relatively poorly, a city can reduce or even stop planting that species and subsequently save money on planting stock and replacement costs. RPI enables managers to look at the performance of long-standing species as well. Species planted for many years that have an RPI of 1.00 have performed well when compared to the population as a whole. These top performers should be maintained as a significant portion of the urban forest population.

An RPI value less than 1.00 may be indicative of a species that is not well adapted to local conditions. Poorly adapted species are more likely to present increased safety and maintenance issues. Species with an RPI less then 1.00 should receive careful consideration before being selected for future planting choices. Prior to selecting trees on the basis of RPI alone, managers are encouraged to take into account the age range of the species. A species that has a RPI of less than 1.00, but has a significant number of trees in larger DBH classes, may just be exhibiting signs of population senescence. The individuals of this species may have produced substantial benefits over the years and should be considered when making species selection decisions.

The RPI value can also be used to identify underutilized species that are demonstrating good performance. Street trees with an RPI value greater than 1.00 representing at least 10% of the total population may be indicating their suitability in the local environment and should receive consideration for additional planting (Table 4).

Of Burbank's large-stature deciduous trees, London planetree (*Platanus hybrida*, RPI-1.06), tulip tree (*Liriodendron tulipifera*, RPI-1.08), and California sycamore (*Platanus racemosa*, RPI-1.06) each demonstrate proven performance. Chinese pistache (*Pistache chinensis*, RPI-1.12), Japanese pogoda tree (*Sophora japonica*, RPI-1.12), and Chinese flame tree (*Koelreuteria bipinnata*, RPI-1.10) are showing promising results as medium-stature decidous trees. A good choice for a small-stature decidous tree may be chitalpa (*Chitalpa spp*., RPI-1.12), cherry plum (*Prunus cerasifera*, RPI-1.07), or mountain ebony (*Bauhinia variegata*, RPI-1.10).

Fern pine (*Podocarpus gracilior*, RPI-1.09), California live oak (*Quercus agrifolia*, RPI-1.05), and evergreen ash (*Fraxinus uhdei*, RPI-1.05) are performing well as large-stature evergreen species. Cajeput (*Melaleuca quinquenervia*, RPI-1.11), cape chestnut (*Calodendrum capense*, RPI-1.10), and Benjimin

Table 4. Burbank's Underutilized Street Trees with RPI > 1.00.

Species	# of Tree in Population	% of Population	RPI
Broadleaf Deciduous Large (BDL)			
Platanus hybrida	874	2.7	**1.06**
Liriodendron tulipifera	478	1.5	**1.08**
Platanus racemosa	415	1.3	**1.06**
Broadleaf Deciduous Medium (BDM)			
Pistacia chinensis	1,132	3.5	**1.12**
Koelreuteria bipinnata	351	1.1	**1.10**
Sophora japonica	226	0.7	**1.12**
Broadleaf Deciduous Small (BDS)			
Chitalpa spp.	364	1.1	**1.12**
Prunus cerasifera	187	0.6	**1.07**
Bauhinia variegata	88	0.3	**1.10**
Broadleaf Evergreen Large (BEL)			
Quercus agrifolia	772	2.4	**1.05**
Podocarpus gracilior	246	0.8	**1.09**
Fraxinus uhdei	172	0.5	**1.05**
Broadleaf Evergreen Medium (BEM)			
Calodendrum capense	50	0.2	**1.10**
Melaleuca quinquenervia	46	0.1	**1.11**
Ficus benjamina	39	0.1	**1.04**
Broadleaf Evergreen Small (BES)			
Pyrus calleryana	1,255	3.9	**1.09**
Tabebuia impetiginosa	483	1.5	**1.09**
Tristaniopsis conferta	257	0.8	**1.09**
Geijera parviflora	198	0.6	**1.11**
Conifer Evergreen Large (CEL)			
Pinus canariensis	910	2.8	**1.10**
Pinus halepensis	533	1.7	**1.05**
Cupressus sempervirens	77	0.2	**1.11**
Pinus pinea	57	0.2	**1.08**

fig (*Ficus benjamina*, RPI-1.04) are performing well as medium-stature evergreens. Australian willow (*Geijera parviflora*, RPI-1.11), Callery pear (*Pyrus calleryana*, RPI-1.09), pink trumpet tree (*Tabebuia impetiginosa*, RPI-1.09), and Brisbane box (*Tristaniopsis conferta*) are performing well as small-stature evergreens.

The top performing large-stature conifers are Italian cypress (*Cupressus sempervirens*, RPI-1.11), Canary island pine (*Pinus canariensis*, RPI-1.10), Italian stone pine (*Pinus pinea*, RPI-1.08), and alleppo pine (*Pinus halepensis*, RPI-1.05)

Canopy Cover

The amount and distribution of leaf surface area is the driving force behind the urban forest's ability to produce benefits for the community (Clark, 1997). As canopy cover increases, so do the benefits afforded by leaf area. It is important to remember that street trees throughout the United States—including Burbank's—likely represent less than 10% of the entire urban forest (Moll and Kollin, 1993). In Burbank, the estimated street tree canopy covers 331 acres (3%) of the total land area of 11,008 acres (17.2 square miles). Burbank's street tree canopy covers 19.8% of the total street and sidewalk area (1,673 acres) within the city.

Burbank's street tree canopy accounts for an estimated 331 acres, equating to 3% of the city's total land area (17.2 mi^2) and 19.8% of total street and sidewalk area (1,673 acres).

Replacement Value

The estimated value of Burbank's public tree resource is $162 million. Community trees are an asset which, if properly cared for, have the potential to increase in value over time as the trees mature. Replacement value accounts for the historical investment in trees over their lifetime and is a way of describing the value of a tree population (and/or average value per tree) at a given time. Replacement value is a reflection of current population numbers, stature, placement, and condition. There are several methods available for obtaining a fair and reasonable perception of a tree's value (CTLA, 1992, Watson, 2002). The cost approach (used in this study) assumes the value of a tree is equal to the cost of replacing a tree in its current state (Cullen, 2002). To replace Burbank's entire population of 32,077 public trees with trees of similar size, species, and condition would cost approximately $162 million (Table 5). The average replacement value per tree is approximately $5,042.

Citywide, camphor (*Cinnamomum camphora*) accounts for 34% of the total replacement value, followed by sweetgum (*Liquidambar styraciflua*, 7.6%), California live oak (*Quercus agrifolia*, 5.7%), southern magnolia (*Magnolia grandiflora*, 5.6%), Canary island pine (*Pinus canariensis*, 5.1%), and London planetree (*Platanus hybrida*, 4.5%). The high values of these species reinforce their importance to the city. Many of the highest value species are large-stature trees with large canopies and, therefore, also have high importance values (IV). Species with low replacement values are usually smaller-stature trees with lower importance values, as evidenced by crapemyrtle (*Lagerstoemia indica*, 2.0%)—despite its prevalence in the population.

Burbank's public trees are an integral component to the city's infrastructure and a public asset valued at $162 million; an asset which, with proper care and maintenance, has the potential to increase in value over time. It is important, however, to distinguish replacement value from the value of annual benefits produced by Burbank's public trees, which is discussed in Chapter Four.

Table 5. Replacement Values of Burbank's Most Valuable Street Tree Species[3].

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Cinnamomum camphora	7,285	39,671	1,122,450	8,572,019	17,514,466	13,414,193	9,698,163	4,324,956	943,744	**55,636,948**	34.40
Lagerstroemia indica	664,548	1,331,590	1,189,425	34,700	0	12,671	33,960	0	0	**3,266,893**	2.02
Liquidambar styraciflua	6,411	46,227	713,272	4,188,342	4,673,122	2,242,575	320,697	21,953	0	**12,212,597**	7.55
Magnolia grandiflora	12,753	90,599	1,418,022	4,059,746	2,335,796	946,790	182,579	39,735	0	**9,086,019**	5.62
Pyrus calleryana	199,684	288,994	721,063	390,530	42,778	0	0	0	0	**1,643,049**	1.02
Fraxinus velutina "Modesto"	979	5,711	414,051	1,477,762	1,730,567	796,735	392,986	21,953	0	**4,840,743**	2.99
Cupaniopsis anacardioides	71,182	126,812	631,478	739,878	82,753	10,999	0	0	0	**1,663,102**	1.03
Pinus canariensis	5,442	24,418	335,503	1,637,931	2,004,544	3,026,808	1,130,650	119,204	0	**8,284,499**	5.12
*Platanus hybrida**	7,978	31,888	138,586	965,158	2,354,218	2,254,259	1,050,153	497,612	0	**7,299,854**	4.51
Quercus agrifolia	15,170	29,913	211,581	785,419	2,404,310	2,855,675	2,255,689	588,489	48,940	**9,195,185**	5.69
Pyrus kawakamii	36,490	124,731	583,385	383,793	0	0	0	0	0	**1,128,400**	0.70
Pinus halepensis	1,423	4,050	135,687	654,480	810,306	1,019,063	1,665,261	1,033,643	449,270	**5,773,182**	3.57
Fraxinus velutina	630	323	82,987	342,254	363,102	258,090	85,119	10,206	0	**1,142,711**	0.71
Brachychiton populneum	2,858	6,494	286,794	690,451	275,574	158,517	0	0	0	**1,420,689**	0.88
Jacaranda mimosifolia	14,587	35,641	257,922	716,987	876,211	173,006	81,638	0	0	**2,155,992**	1.33
Platanus racemosa	1,889	1,330	118,075	522,008	924,912	1,683,557	1,512,559	425,396	46,287	**5,236,013**	3.24
Quercus ilex	2,173	14,201	255,933	992,382	703,852	263,685	120,682	0	0	**2,352,907**	1.45
Ulmus parvifolia	1,885	12,861	66,574	512,493	1,168,878	154,001	60,459	0	0	**1,977,150**	1.22
Ficus retusa ssp nitida	1,317	5,366	55,615	957,000	1,574,015	565,151	0	0	0	**3,158,463**	1.95
Ceratonia siliqua	336	0	8,311	61,490	294,294	292,707	332,245	178,413	44,536	**1,212,331**	0.75
All Other Species	727,980	1,416,437	5,346,052	4,713,434	3,201,903	3,119,467	2,463,665	1,157,621	887,462	**23,034,020**	14.25
Citywide total	**1,782,999**	**3,637,256**	**14,092,765**	**33,398,255**	**43,335,599**	**33,247,947**	**21,386,504**	**8,419,181**	**2,420,239**	**161,720,744**	**100.00**

[3] Species listed represent RVs >$1 million total. All other species are included in "Other". See Appendix B for replacement values of all street tree species.

Chapter 3: Benefits of Burbank's Public Trees

Street trees are important to Burbank; environmentally, they help conserve and reduce energy use, reduce local carbon dioxide (CO_2) levels, improve air quality, and mitigate stormwater runoff. Additionally, trees provide a wealth of well-documented psychological, social, and economic benefits related primarily to their beauty and calming effect. Environmentally, trees make good sense, working ceaselessly to provide benefits back to the community; but are the collective benefits worth the costs of management? In other words, are street trees a good investment for Burbank? To answer that question, we must first quantify these benefits in financial terms.

This study utilized the city's public tree inventory and i-Tree's STRATUM model to assess and quantify the beneficial functions of Burbank's public tree resource and to place a dollar value on the annual environmental benefits they provide. These estimates provide first-order approximations of tree value. STRATUM only generally accounts for the benefits produced by Burbank's public trees, an accounting that is based on the best available science with an accepted degree of uncertainty that can nonetheless provide a platform from which real management decisions can be made (Maco and McPherson, 2003). A discussion on the methods used to quantify and price these benefits can be found in Appendix A.

Energy Savings

Trees modify climate and conserve energy in three principal ways:

- Shading reduces the amount of radiant energy absorbed and stored by hardscape surfaces, thereby reducing the overall heat island effect.
- Transpiration converts moisture to water vapor, cooling the air by using solar energy that would otherwise result in heating of the air.
- Wind speed reduction reduces the movement of outside air into interior spaces and conductive heat loss where thermal conductivity is relatively high (e.g., glass windows (Simpson, 1998)).

Urban trees reduce heat island effects, cooling through shading, transpiration, and wind-speed reduction. These modifications to local climate reduce energy usage and are a quantifiable benefit trees provide to the community.

Trees and other vegetation within an urbanized environment may lower air temperatures 5° F (3° C) compared to outside the green space (Chandler, 1965). On a larger citywide scale, temperature differences of more than 9° F (5° C) have been observed between city centers without adequate canopy coverage and more vegetated suburban areas (Akbari and others, 1992). The relative importance of these effects depends on the size and configuration of trees and other landscape elements (McPherson, 1993). Tree spacing,

crown spread, and vertical distribution of leaf area each influence the transport of warm air and pollutants along streets and out of urban canyons.

By reducing air movement into buildings and against conductive surfaces (e.g., glass, metal siding) trees reduce conductive heat loss from buildings. Trees can reduce wind speed and the resulting air infiltration by up to 50%, translating into potential annual heating savings of 25% (Heisler, 1986).

Electricity and Natural Gas Results

Electricity and natural gas saved annually in Burbank from both the shading and climate effects of public trees is equal to 1,889 MWh ($307,471) and13,947 therms ($18,270), for a total retail savings of approximately $325,741 or a citywide average of $10.15 per public tree (Table 6). Camphor (*Cinnamomum camphora*) which represents 13.5% of the population and has an IV of 20, accounts for 26.1% of the total energy savings. Southern magnolia (*Magnolia grandiflora*, 7.8%), and sweet gum (*Liquidambar styraciflua*, 7.2%) provide the next greatest contribution towards total energy savings, due in large part to their prevalence in the population (6.7% and 7.4% respectively). Crapemyrtle (*Lagerstroemia indica*) the second most abundant public tree in Burbank (10.4% of the total population), accounts for only 3.4% of the total energy savings due to its smaller stature.

Examining average energy savings on a per tree basis, California sycamore (*Platanus racemosa*, $22.51), London planetree (*Platanus hybrida*, $21.96), and alleppo pine (*Pinus halepensis*, $20.81), are the greatest contributors, primarily due to their large stature and relatively mature age distribution as compared to the rest of the tree population. Small-stature trees, such as pink trumpet tree (*Tabebuia impetiginosa*, $1.84), callery pear (*Pyrus calleryana*, $2.31) and crapemyrtle (*Lagerstoemia indica*, $3.34) are providing energy-saving benefits well below that of the average of $10.15. But while Chinese pistache (*Pistacia chinensis*, $3.06) are currently well below average, it is important to recognize that 74% of these trees are currently less than six inches in diameter DBH, therefore greater benefits can be expected as this species matures.

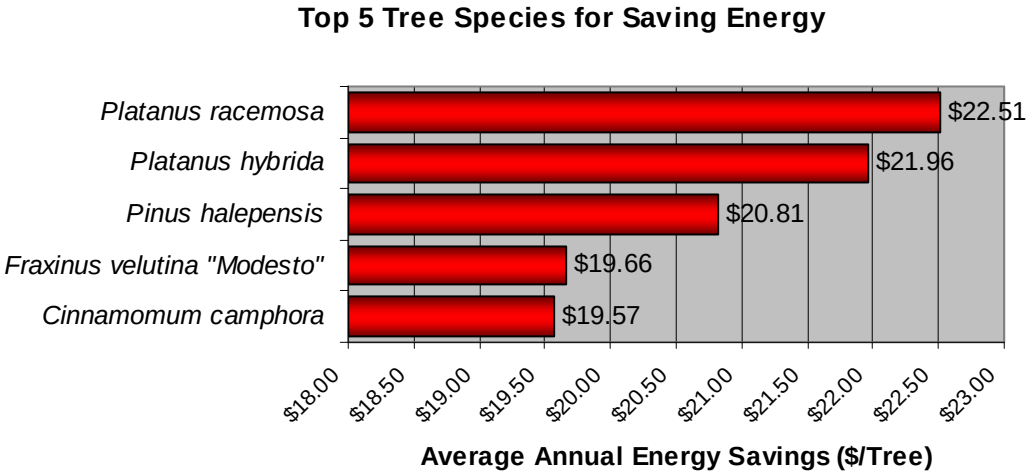


Figure 6. Top Five Energy Saving Trees in Burbank's Urban Forest.

Table 6. Annual Energy Savings Produced by Burbank's Public Trees.

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Total Population	% of Total $	Avg. $/tree
Cinnamomum camphora	487.59	79,384.37	4,301.13	5,634.48	**85,018.84**	13.54	26.10	**19.57**
Lagerstroemia indica	63.64	10,361.84	575.31	753.66	**11,115.50**	10.38	3.41	**3.34**
Liquidambar styraciflua	133.59	21,749.18	1,401.52	1,835.98	**23,585.17**	7.37	7.24	**9.97**
Magnolia grandiflora	148.69	24,209.01	908.32	1,189.89	**25,398.91**	6.68	7.80	**11.85**
Pyrus calleryana	17.14	2,789.98	82.61	108.22	**2,898.20**	3.91	0.89	**2.31**
Pistacia chinensis	20.50	3,337.71	98.17	128.60	**3,466.31**	3.53	1.06	**3.06**
Fraxinus velutina "Modesto"	127.81	20,808.72	519.99	681.18	**21,489.91**	3.41	6.60	**19.66**
Cupaniopsis anacardioides	37.27	6,068.16	550.36	720.97	**6,789.13**	3.27	2.08	**6.47**
Pinus canariensis	61.32	9,983.51	357.74	468.64	**10,452.16**	2.84	3.21	**11.49**
Platanus hybrida	113.83	18,532.58	501.86	657.44	**19,190.02**	2.72	5.89	**21.96**
Washingtonia robusta	12.86	2,094.34	170.69	223.60	**2,317.94**	2.55	0.71	**2.83**
Quercus agrifolia	56.10	9,133.34	408.48	535.11	**9,668.46**	2.41	2.97	**12.52**
Pyrus kawakamii	13.17	2,144.90	54.57	71.49	**2,216.39**	2.06	0.68	**3.35**
Pinus halepensis	64.93	10,571.36	398.97	522.65	**11,094.01**	1.66	3.41	**20.81**
Fraxinus velutina	31.42	5,116.27	242.09	317.14	**5,433.41**	1.55	1.67	**10.93**
Brachychiton populneum	35.09	5,713.76	289.74	379.57	**6,093.32**	1.53	1.87	**12.41**
Tabebuia impetiginosa	5.22	849.67	29.02	38.01	**887.69**	1.51	0.27	**1.84**
Liriodendron tulipifera	17.67	2,876.54	41.40	54.24	**2,930.79**	1.49	0.90	**6.13**
Jacaranda mimosifolia	18.73	3,049.42	167.38	219.26	**3,268.68**	1.44	1.00	**7.06**
Platanus racemosa	55.39	9,018.51	245.71	321.88	**9,340.39**	1.29	2.87	**22.51**
Quercus ilex	18.90	3,077.39	154.63	202.56	**3,279.95**	1.26	1.01	**8.12**
Chitalpa spp.	8.04	1,308.32	72.55	95.04	**1,403.36**	1.13	0.43	**3.86**
Gleditsia traicanthos	18.71	3,046.35	43.39	56.84	**3,103.20**	1.13	0.95	**8.60**
Koelreuteria bipinnata	12.11	1,971.51	103.11	135.07	**2,106.59**	1.09	0.65	**6.00**
Ulmus parvifolia	20.25	3,297.02	157.37	206.15	**3,503.17**	1.06	1.08	**10.33**
Other street trees	288.54	46,977.53	2,070.50	2,712.36	**49,689.89**	19.17	15.25	**8.08**
Citywide Total	**1,888.53**	**307,471.34**	**13,946.61**	**18,270.06**	**325,741.41**	**100.00**	**100.00**	**10.15**

Atmospheric Carbon Dioxide Reduction

As environmental awareness continues to increase, governments are paying particular attention to global warming and the effects of greenhouse gas emissions. Two national policy options currently under debate, establishment of a carbon tax and a greenhouse gas cap-and-trade system, are aimed at the reduction of atmospheric carbon dioxide (CO_2)and other greenhouse gases. A carbon tax would place a tax burden on each unit of greenhouse gas emissions and would require regulated entities to pay for their level of emissions. Alternatively, in a cap-and-trade system, an upper limit (or cap) is placed on global (federal, regional, or other jurisdiction) levels of greenhouse gas emissions and the regulated entities would be required to either reduce emissions to required limits or purchase emissions allowances in order to meet the cap (Williams and others, 2007). The concept of purchasing emission allowances (offsets) has led to the acceptance of carbon credits as a commodity that can be exchanged for financial gain. Trading systems, such as the Chicago Climate Exchange, are still exploring the functions of urban forests or, more precisely, aggregations of regional urban forest benefits, for relevancy in this new market. While Burbank's urban forest resource may not reduce large enough quantities of greenhouse gases to be traded in the open market, the city's street trees are nonetheless reducing atmospheric carbon dioxide for a positive environmental and financial benefit to the community.

Urban trees reduce atmospheric carbon dioxide (CO_2) in two ways:

- Directly, through growth and the sequestration of CO_2 as woody and foliar biomass.
- Indirectly, by lowering the demand for heating and air conditioning, thereby reducing the emissions associated with electric power generation and natural gas consumption.

Conversely, CO_2 is released by vehicles, chain saws, chippers, and other equipment used to plant and care for trees. Additionally, when a tree dies, most of the CO_2 that accumulated as woody biomass is released back into the atmosphere during decomposition, unless the wood is recycled. These factors must be taken into consideration when calculating the CO_2 reduction benefits of trees.

Sequestered Carbon Dioxide

Burbank's public tree resource directly reduces 1,569 tons of CO_2 into woody and foliar biomass, valued at $47,060. Accounting for CO_2 emissions from tree decomposition (-301 tons) and tree-related maintenance activity (-3 tons), Burbank's public trees reduce atmospheric CO_2 by a net of 1,265 tons, valued at $37,942 per year (Table 7). Per tree net benefit is $1.18. California live oak (*Quercus agrifolia*, $6.11) and velvet ash (*Fraxinus velutina*, $4.83) provide the highest per tree benefit. Camphor (*Cinnamomum camphora*) is providing the greatest percentage of overall benefits at 24.9% due primarily to its prevalence in the population.

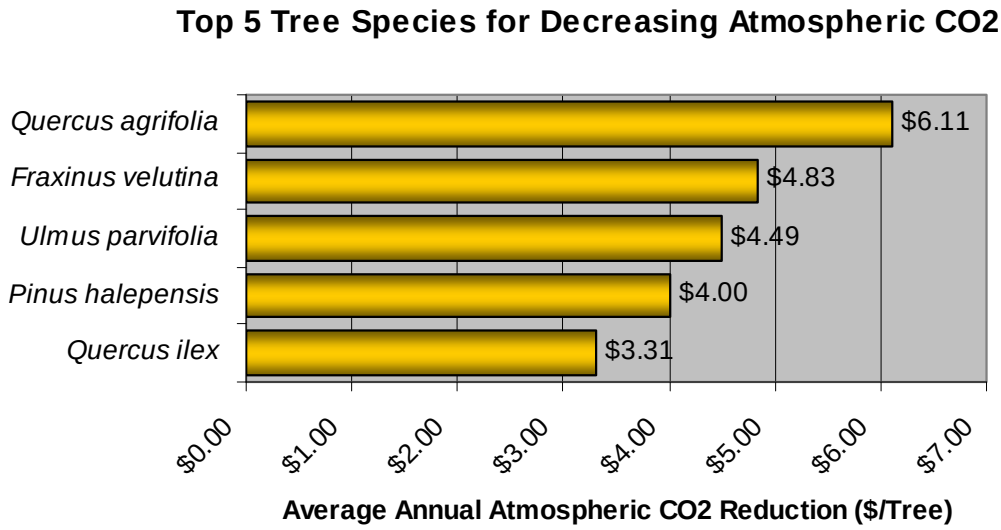
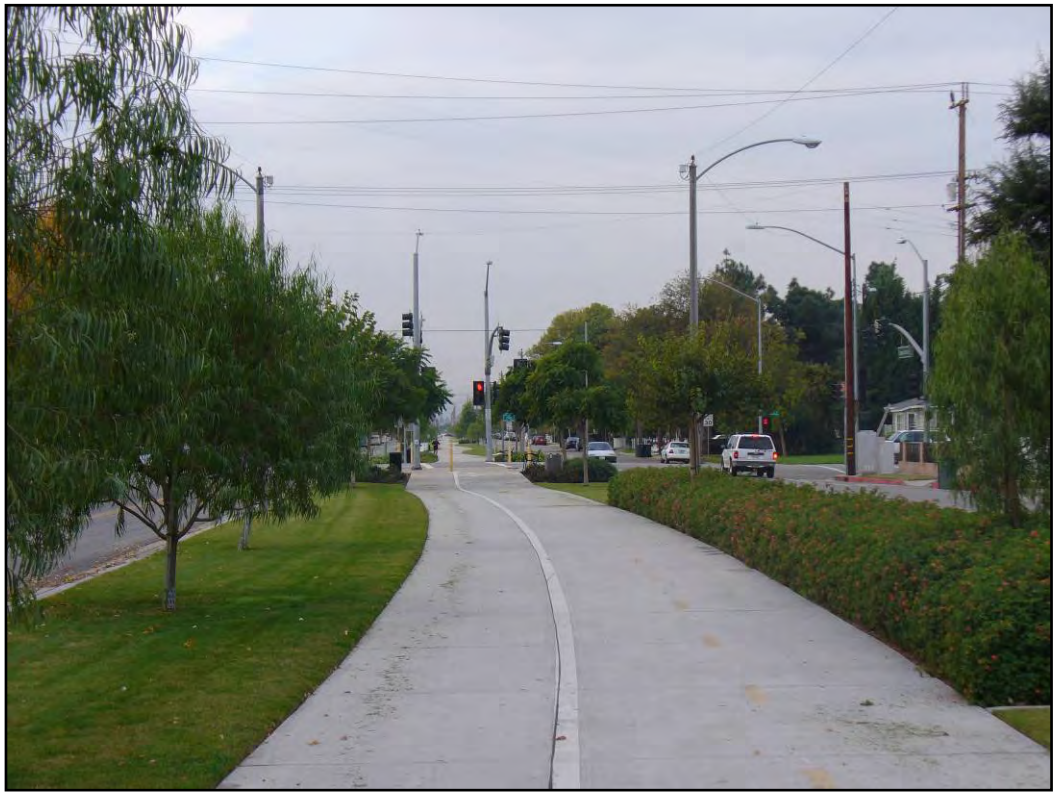


Figure 7. Top Five Species for Atmospheric CO_2 Reduction in Burbank.



Urban trees reduce atmospheric CO_2, providing environmental and financial benefits to the community.

Table 7. Net Atmospheric CO_2 Reduction by Burbank's Public Trees.

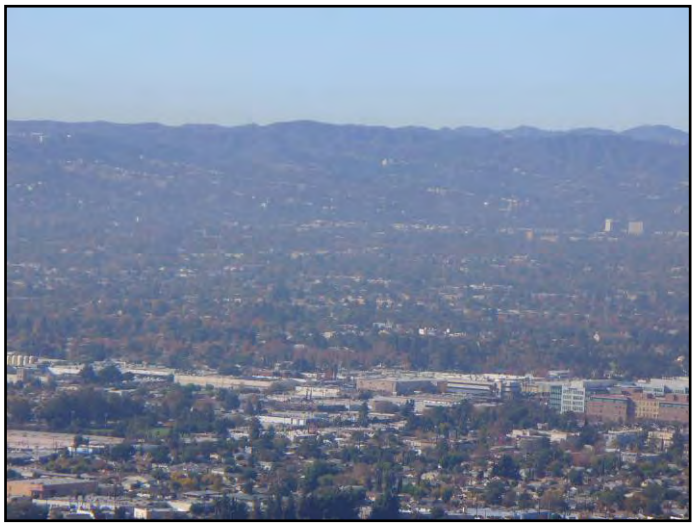
Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Net Total (lb)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Cinnamomum camphora	842,510.13	12,637.65	- 210,956.84	- 847.09	- 3,177.06	630,706.19	**9,460.59**	13.54	24.93	**2.18**
Lagerstroemia indica	37,153.67	557.30	- 2,864.79	- 649.36	- 52.71	33,639.52	**504.59**	10.38	1.33	**0.15**
Liquidambar styraciflua	38,198.56	572.98	- 31,211.39	- 461.18	- 475.09	6,525.99	**97.89**	7.37	0.26	**0.04**
Magnolia grandiflora	159,346.56	2,390.20	- 28,473.60	- 417.89	- 433.37	130,455.07	**1,956.83**	6.68	5.16	**0.91**
Pyrus calleryana	10,049.29	150.74	- 2,251.39	- 244.73	- 37.44	7,553.17	**113.30**	3.91	0.30	**0.09**
Pistacia chinensis	18,755.12	281.33	- 1,749.86	- 220.74	- 29.56	16,784.52	**251.77**	3.53	0.66	**0.22**
Fraxinus velutina "Modesto"	112,923.80	1,693.86	- 26,902.44	- 213.14	- 406.73	85,808.22	**1,287.12**	3.41	3.39	**1.18**
Cupaniopsis anacardioides	44,721.12	670.82	- 8,661.16	- 204.75	- 132.99	35,855.21	**537.83**	3.27	1.42	**0.51**
Pinus canariensis	112,300.01	1,684.50	- 28,209.58	- 177.45	- 425.81	83,912.97	**1,258.70**	2.84	3.32	**1.38**
Platanus hybrida	66,655.48	999.83	- 28,864.82	- 170.43	- 435.53	37,620.22	**564.30**	2.72	1.49	**0.65**
Washingtonia robusta	23,973.73	359.61	- 7,320.95	- 159.51	- 112.21	16,493.27	**247.40**	2.55	0.65	**0.30**
Quercus agrifolia	351,151.69	5,267.27	- 36,389.53	- 150.54	- 548.10	314,611.63	**4,719.17**	2.41	12.44	**6.11**
Pyrus kawakamii	5,837.12	87.56	- 1,872.02	- 129.09	- 30.02	3,836.00	**57.54**	2.06	0.15	**0.09**
Pinus halepensis	168,178.84	2,522.68	- 25,778.61	- 103.94	- 388.24	142,296.30	**2,134.44**	1.66	5.63	**4.00**
Fraxinus velutina	175,913.48	2,638.70	- 15,646.05	- 96.92	- 236.14	160,170.52	**2,402.56**	1.55	6.33	**4.83**
Brachychiton populneum	68,593.85	1,028.91	- 9,011.14	- 95.75	- 136.60	59,486.97	**892.30**	1.53	2.35	**1.82**
Tabebuia impetiginosa	3,625.28	54.38	- 666.90	- 94.19	- 11.42	2,864.19	**42.96**	1.51	0.11	**0.09**
Liriodendron tulipifera	24,221.87	363.33	- 1,891.89	- 93.21	- 29.78	22,236.77	**333.55**	1.49	0.88	**0.70**
Jacaranda mimosifolia	2,450.86	36.76	- 1,090.85	- 90.29	- 17.72	1,269.73	**19.05**	1.44	0.05	**0.04**
Platanus racemosa	27,526.44	412.90	- 14,113.60	- 80.93	- 212.92	13,331.92	**199.98**	1.29	0.53	**0.48**
Quercus ilex	96,845.78	1,452.69	- 7,581.14	- 78.78	- 114.90	89,185.86	**1,337.79**	1.26	3.53	**3.31**
Chitalpa spp.	4,065.63	60.98	- 390.87	- 70.98	- 6.93	3,603.77	**54.06**	1.13	0.14	**0.15**
Gleditsia traicanthos	26,149.60	392.24	- 1,753.07	- 70.40	- 27.35	24,326.13	**364.89**	1.13	0.96	**1.01**
Koelreuteria bipinnata	7,063.26	105.95	- 2,116.31	- 68.45	- 32.77	4,878.51	**73.18**	1.09	0.19	**0.21**
Ulmus parvifolia	110,756.05	1,661.34	- 9,254.92	- 66.11	- 139.82	101,435.02	**1,521.53**	1.06	4.01	**4.49**
Other street trees	598,384.94	8,975.77	- 96,620.45	- 1,199.26	- 1,467.30	500,565.22	**7,508.48**	19.17	19.79	**1.22**
Citywide total	**3,137,351.75**	**47,060.28**	**- 601,644.19**	**- 6,255.07**	**- 9,118.49**	**2,529,452.50**	**37,941.77**	**100.00**	**100.00**	**1.18**

Air Quality Improvement

Urban trees improve air quality in five fundamental ways:

- Absorption of gaseous pollutants such as ozone (O_3) and nitrogen dioxide (NO_2) through leaf surfaces.
- Interception of particulate matter (PM_{10}), such as dust, ash, dirt, pollen, and smoke.
- Reduction of emissions from power generation by reducing energy consumption.
- Increase of oxygen levels through photosynthesis.
- Transpiration of water and shade provision, resulting in lower local air temperatures, thereby reducing O_3 levels.

The California Air Resources Board has identified that, between the years 2006 to 2007, the Burbank-W. Palm Ave. monitoring station recorded ozone levels exceeding the state one-hour standard for ozone level 38 days, compared to the Los Angeles county average of 31 days. During the same time frame, ozone levels at this station exceeded the state eight-hour standard 53 days compared to the Los Angeles county average of 48 (Table 8). Additionally, in 2006, the South Coast Air Quality Management District listed Burbank as number six out of ten in the nation for cities with the worst particulate matter. None of this is surprising considering that Burbank is home to the Bob Hope Airport, along with its proximity to two heavily traveled freeways. The Port of Los Angeles (which is responsible for 25% of the region's pollution) is also in the within range to affect the air quality of the city of Burbank. Finally, geographically, Burbank is backed up against the Verdugo Mountains, which tend to trap air pollution from neighboring cities. Given the concern over air quality in Burbank, the air quality benefits provided by trees present a strong argument for the protection and maintenance of Burbank's public tree population.



Given the concern over air quality in Burbank, the air quality benefits provided by trees present a strong argument for the protection and maintenance of Burbank's public tree population.

Table 8. Number of Days Ozone Levels Exceed California State Standards.

Monitoring Station	2006 – 2007	
	Ozone > State 1-hr. Standard	Ozone > State 8-hr. Standard
Azusa	46	75.1
Burbank-W. Palm Ave.	38	53
Glendora-Laurel	62	85
Lebec-Peace Valley Rd.	14	57
Los Angeles-N. Main St.	11	13
Los Angeles-Westchester Pkwy.	0	1
Lynwood	1	2
North Long Beach	1	1
Pasadena-S. Wilson Ave.	39	56
Pico Rivera-4144 San Gabriel	15	18
Pomona	53	67
Reseda	55	98
Santa Clarita	93	146
West Los Angeles-VA Hospital	5	4
Average	**31**	**48**

In the absence of cooling effects provided by trees, higher temperatures contribute to ozone (O_3) formation. Additionally, short-term increases in ozone concentrations have been statistically associated with increased tree mortality for 95 large U. S. cities (Bell and others, 2004). However, it should be noted that while trees do a great deal to absorb air pollutants (especially ozone and particulate matter), they also negatively contribute to air pollution. Trees emit various biogenic volatile organic compounds (BVOCs), such as isoprenes and monoterpenes, which can also contribute to ozone formation. These BVOC emissions are accounted for by STRATUM in the air quality net benefit.

Deposition and Interception

Each year, 6.5 tons of NO_2, small particulate matter (PM_{10}), O_3, and sulfur dioxide (SO_2) are intercepted or absorbed by public trees in Burbank, for a value of $687,571 (Table 8). As a population, camphor (*Cinnamomum camphora*, 3.5 tons), common crapemyrtle (*Lagerstroemia indical*, 0.5 tons), and alleppo pine (*Pinus halepensis*, 0.5 tons) are the greatest contributors to air quality improvements, accounting for 72% of the total benefits.

Avoided Pollutants

By reducing energy needs, the energy savings provided by trees have the additional indirect benefit of reducing air pollutant emissions (NO_2, PM_{10}, VOCs) that result from energy production. Altogether, 908 pounds of pollutants, valued at $31,687, are avoided annually through the shading effects of Burbank's public trees. The populations of camphor (*Cinnamomum camphora*, 242 lbs.), southern magnolia (*Magnolia grandiflora*, 69 lbs.), and sweetgum (*Liquidambar styraciflua*, 68 lbs.) provide a combined 42% of the total benefits and have the greatest impact on reducing energy needs and avoiding the additional generation of pollutants.

BVOC Emissions

Biogenic volatile organic compound (BVOC) emissions from trees, which negatively affect air quality, must be considered. Nearly eight tons annually are emitted from Burbank's public trees, offsetting the total air quality benefit by $51,730. Liquidambar are the heaviest emitters of BVOCs, accounting for 21% (1.6 tons) of the public tree population's BVOC emissions, while only representing 7% of the total inventory. The large amount of BVOC emissions by the liquidambar population outweigh the benefits of air pollutants deposited, removed, and avoided in terms of pounds of pollutants. However, the monetary value of the air pollutants removed is greater than the disadvantage of BVOC emissions, creating a positive flow of monetary benefits in terms of air quality for the liquidambar population.

Net Air Quality Improvement

Net air pollutants removed, avoided, and released by the Burbank's public tree population are valued at $687,571 per year. The average net benefit per tree is $21.44. Trees vary dramatically in their ability to produce net air quality benefits. Typically, large-canopied trees with large leaf surface areas that are not high emitters of BVOCs produce the greatest benefits. On a per tree basis, Burbank's sycamore (*Platanus racemosa*), London planetree (*Platanus hybrida*), and alleppo pine (*Pinus halepensis*) produce the greatest net air quality improvements, valued at over $50 per tree. By a wide margin, partially due to its prevalence in the population, but also due to the fact that it is a great performer with no BVOC emissions, camphor tree (*Cinnamomum camphora*) accounts for the greatest air quality improvements in terms of total benefits by species. Burbank's camphor trees collectively remove nearly 3.5 tons of pollutants at a value of $183,465 annually.

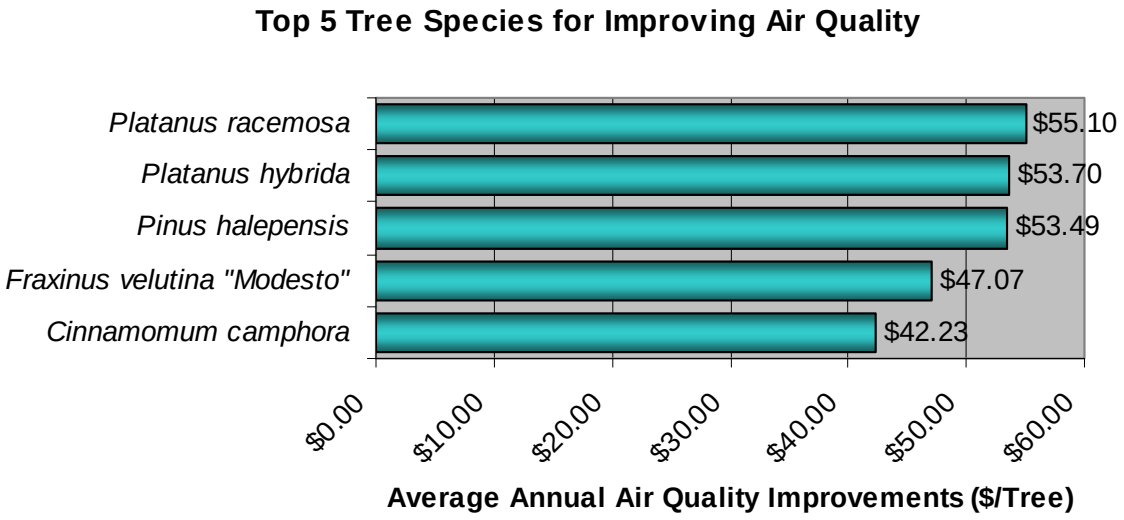


Figure 8. Top Five Trees for Improving Burbank's Air Quality.

Table 9. Annual Air Quality Benefits Provided by Burbank's Public Trees.

Species	Deposition O3 (lb)	Deposition NO2 (lb)	Deposition PM10 (lb)	Deposition SO2 (lb)	Total Deposition ($)	Avoided NO2 (lb)	Avoided PM10 (lb)	Avoided VOC (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% of Total Pop.	Avg. $/tree
Cinnamomum camphora	3,452	1,302	1,834	135	**175,177**	27	149	66	**8,289**	0	**0**	6,965	**183,465**	14	**42**
Lagerstroemia indica	544	254	315	19	**29,680**	3	20	9	**1,077**	0	**0**	1,163	**30,757**	10	**9**
Liquidambar styraciflua	651	215	326	26	**31,505**	9	41	18	**2,342**	- 3,269	**- 10,917**	- 1,982	**22,930**	7	**10**
Magnolia grandiflora	798	264	399	32	**38,611**	4	45	20	**2,456**	- 943	**- 3,151**	618	**37,916**	7	**18**
Pyrus calleryana	134	63	78	5	**7,326**	0	5	2	**276**	0	**0**	287	**7,602**	4	**6**
Pistacia chinensis	96	32	48	4	**4,629**	0	6	3	**338**	- 332	**- 1,108**	- 144	**3,859**	4	**3**
Fraxinus velutina "Modesto"	1,001	466	578	36	**54,544**	1	39	17	**2,068**	- 1,547	**- 5,168**	590	**51,443**	3	**47**
Cupaniopsis anacardioides	332	155	192	12	**18,087**	4	12	5	**672**	- 768	**- 2,564**	- 57	**16,195**	3	**15**
Pinus canariensis	380	177	220	14	**20,741**	2	19	8	**1,028**	- 793	**- 2,647**	28	**19,122**	3	**21**
Platanus hybrida	921	429	532	33	**50,196**	2	34	15	**1,846**	- 1,529	**- 5,106**	437	**46,936**	3	**54**
Washingtonia robusta	80	37	46	3	**4,349**	1	4	2	**233**	- 47	**- 156**	126	**4,426**	3	**5**
Quercus agrifolia	444	207	256	16	**24,181**	2	17	8	**941**	- 1,070	**- 3,573**	- 121	**21,548**	2	**28**
Pyrus kawakamii	101	47	58	4	**5,512**	0	4	2	**211**	0	**0**	216	**5,723**	2	**9**
Pinus halepensis	515	240	298	18	**28,091**	2	20	9	**1,077**	- 196	**- 655**	906	**28,513**	2	**53**
Fraxinus velutina	243	113	140	9	**13,225**	1	10	4	**530**	- 530	**- 1,771**	- 11	**11,984**	2	**24**
Brachychiton populneum	232	88	123	9	**11,778**	2	11	5	**594**	0	**0**	469	**12,372**	2	**25**
Tabebuia impetiginosa	42	19	24	1	**2,262**	0	2	1	**85**	0	**0**	89	**2,347**	2	**5**
Liriodendron tulipifera	127	59	73	5	**6,923**	0	5	2	**281**	- 183	**- 610**	89	**6,594**	1	**14**
Jacaranda mimosifolia	158	74	92	6	**8,639**	1	6	3	**317**	0	**0**	339	**8,956**	1	**19**
Platanus racemosa	449	209	259	16	**24,459**	1	17	7	**899**	- 746	**- 2,491**	212	**22,867**	1	**55**
Quercus ilex	145	68	84	5	**7,901**	1	6	3	**320**	- 304	**- 1,017**	6	**7,204**	1	**18**
Chitalpa spp.	69	32	40	2	**3,738**	0	2	1	**136**	0	**0**	146	**3,874**	1	**11**
Gleditsia traicanthos	133	62	77	5	**7,247**	0	6	3	**298**	- 181	**- 604**	103	**6,941**	1	**19**
Koelreuteria bipinnata	58	19	29	2	**2,804**	1	4	2	**208**	- 254	**- 849**	- 140	**2,163**	1	**6**
Ulmus parvifolia	155	72	90	6	**8,458**	1	6	3	**342**	- 328	**- 1,096**	4	**7,704**	1	**23**
Other street trees	2,190	978	1,242	80	**117,552**	11	88	39	**4,826**	- 2,469	**- 8,246**	2,159	**114,131**	19	**19**
Citywide total	**13,450**	**5,678**	**7,451**	**501**	**707,614**	**75**	**577**	**256**	**31,687**	**- 15,488**	**- 51,730**	**12,500**	**687,571**	**100**	**21**

Stormwater Runoff Reductions

According to federal Clean Water Act regulations, municipalities must obtain a permit for managing their stormwater discharges into water bodies. Each city's program must identify the *best management practices* (BMPs) it will implement to reduce its pollutant discharge. Rainfall interception by trees can reduce the amount of stormwater that enters collection and treatment facilities during large storm events. Trees are mini-reservoirs, controlling runoff at the source. This is especially important in an urban setting with a significant quantity of impervious surfaces in relative proximity to the Pacific Ocean. Healthy urban trees can reduce the amount of runoff and pollutant loading in receiving waters in three primary ways:

- Leaves and branch surfaces intercept and store rainfall, thereby reducing runoff volumes and delaying the onset of peak flows.
- Root growth and decomposition increase the capacity and rate of soil infiltration by rainfall and reduce overland flow.
- Tree canopies reduce soil erosion and surface flows by diminishing the impact of raindrops on barren surfaces.

Burbank's public trees intercept 22.4 million gallons of stormwater annually, or 700 gallons per tree on average (Table 10). The total value of this benefit to the city is $41,081 at an average value of $1.28 per tree. Alleppo pines (*Pinus halepensis*) provide the greatest per tree benefits of $3.58 and, while comprising only 1.7% of the total population, provide 4.7% of the total stormwater benefits. Due in part to its prevalence in the population (13.5%), camphor trees (*Cinnamomum camphora*) provide the greatest overall percentage of benefits (27.9%) and a per tree benefit of $2.64.

Since 62% of Burbank's tulip trees (*Liriodendron tulipifera*) are immature (< 6 inches DBH) their stormwater reduction benefits, currently $0.67 per tree, can be expected to increase as they mature into large trees. However, crapemytle ($0.26 per tree) would not be expected to improve in stormwater reduction benefits due to its smaller stature.

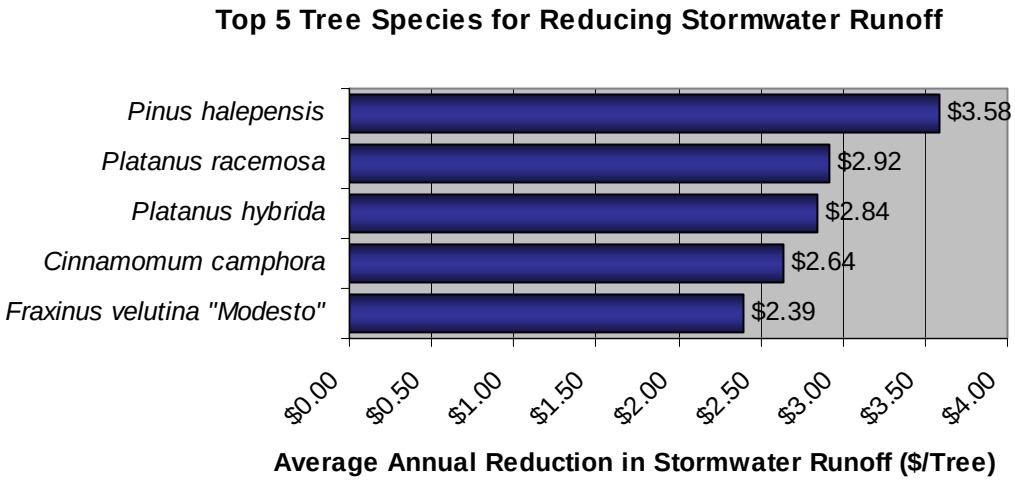


Figure 9. Top Five Trees for Reducing Stormwater Runoff in Burbank.

Table 10. Annual Stormwater Reduction Benefits of Burbank's Public Trees.

Species	Total Rainfall Interception (Gal)	Total ($)	% of Total Tree Population	% of Total $	Avg. $/tree
Cinnamomum camphora	6,259,749	**11,456**	13.54	27.89	**2.64**
Lagerstroemia indica	474,029	**867**	10.38	2.11	**0.26**
Liquidambar styraciflua	1,051,738	**1,924**	7.37	4.69	**0.81**
Magnolia grandiflora	1,715,819	**3,140**	6.68	7.64	**1.47**
Pyrus calleryana	207,082	**378**	3.91	0.92	**0.30**
Pistacia chinensis	131,090	**239**	3.53	0.58	**0.21**
Fraxinus velutina "Modesto"	1,428,305	**2,613**	3.41	6.36	**2.39**
Cupaniopsis anacardioides	431,391	**789**	3.27	1.92	**0.75**
Pinus canariensis	1,060,936	**1,941**	2.84	4.73	**2.13**
Platanus hybrida	1,358,285	**2,485**	2.72	6.05	**2.84**
Washingtonia robusta	213,098	**390**	2.55	0.95	**0.48**
Quercus agrifolia	747,711	**1,368**	2.41	3.33	**1.77**
Pyrus kawakamii	157,004	**287**	2.06	0.70	**0.43**
Pinus halepensis	1,043,815	**1,910**	1.66	4.65	**3.58**
Fraxinus velutina	389,182	**712**	1.55	1.73	**1.43**
Brachychiton populneum	399,923	**731**	1.53	1.78	**1.49**
Tabebuia impetiginosa	64,145	**117**	1.51	0.29	**0.24**
Liriodendron tulipifera	175,105	**320**	1.49	0.78	**0.67**
Jacaranda mimosifolia	143,517	**262**	1.44	0.64	**0.57**
Platanus racemosa	662,206	**1,211**	1.29	2.95	**2.92**
Quercus ilex	227,817	**416**	1.26	1.01	**1.03**
Chitalpa spp.	60,369	**110**	1.13	0.27	**0.30**
Gleditsia traicanthos	179,212	**327**	1.13	0.80	**0.91**
Koelreuteria bipinnata	87,821	**160**	1.09	0.39	**0.46**
Ulmus parvifolia	244,868	**448**	1.06	1.09	**1.32**
Other street trees	3,532,900	**6,465**	19.17	15.74	**1.05**
Citywide total	**22,447,130**	**41,081**	**100.00**	**100.00**	**1.28**

Aesthetic, Property Value, Social, Economic, and Other Benefits

Trees provide beauty in the urban landscape, privacy to homeowners, improved human health, a sense of comfort and place, and refuge for urban wildlife. There is documented evidence that trees promote better business by stimulating more frequent and extended shopping, and a willingness to pay more for goods and parking (Wolf, 1999). Some of these benefits may be captured as a percentage of the value of the property on which a tree stands.

To determine the value of these less tangible benefits, research that compares differences in sales prices of homes was used to estimate the contribution associated with trees. Differences in housing prices in relation to the presence (or lack) of a street tree help define the aesthetic value of street trees in the urban environment. Consideration is given to the location of the street tree in relation to the land use. Street trees located in front of multi-family homes will not increase the property value at the same rate as single-family homes.

Furthermore, street trees located adjacent to commercial and nonresidential properties do not have the same resale potential as residential areas. These factors are taken into consideration and the value of those trees is adjusted accordingly.

Trees provide beauty in the urban landscape, privacy to homeowners, improved human health, a sense of comfort and place, and refuge for urban wildlife.

The calculation of annual aesthetic and other benefits corresponds with a tree's annual increase in leaf area. When a tree is actively growing, leaf area may increase dramatically. Once a tree is mature, there may be little or no net increase in leaf area from one year to the next; thus, there is little or no incremental annual aesthetic benefit for that year, although the cumulative benefit over the course of the entire life of the tree may be large. Since this report represents a one-year snapshot of the street tree population, benefits reflect the increase in leaf area for each tree over the course of one year. As a result, a very young population of 100 callery pears (*Pyrus calleryana*) will have a greater annual aesthetic benefit than an equal number of mature planetrees (*Platanus hybrida*). However, the cumulative aesthetic value of the planetrees would be much greater than that of the pears.

The estimated total annual benefit associated with property value increases and other less tangible benefits is $3.2 million, an average of $100 per tree (Table 11). Tree species that produced the highest average annual aesthetic benefits include alleppo pine (*Pinus halepensis*, $399), honeylocust (*Gleditsia traicanthos*, $247), Modesto ash (*Faxinus velutina* "Modesto", $240), tulip tree (*Liriodendron tulipifera*, $225), and coastal live oak (*Quercus agrifolia*, $197). Some species rank high due to their size and growth rates, but may not be desirable to plant for other reasons. For example, the majority (79%) of Burbank's Modesto ash, which has a very low relative performance index of 0.79, are in only fair condition and 7.4% are in poor condition. Therefore, an investment in Modesto ash with the expectation of receiving high aesthetic benefits may in fact lead to greater liability and increased maintenance costs, negating any relative aesthetic benefits.

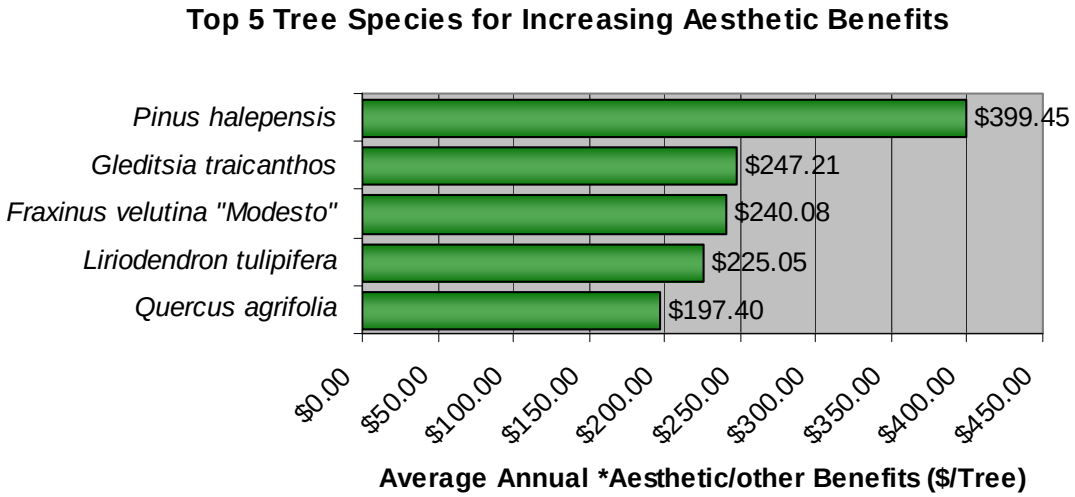
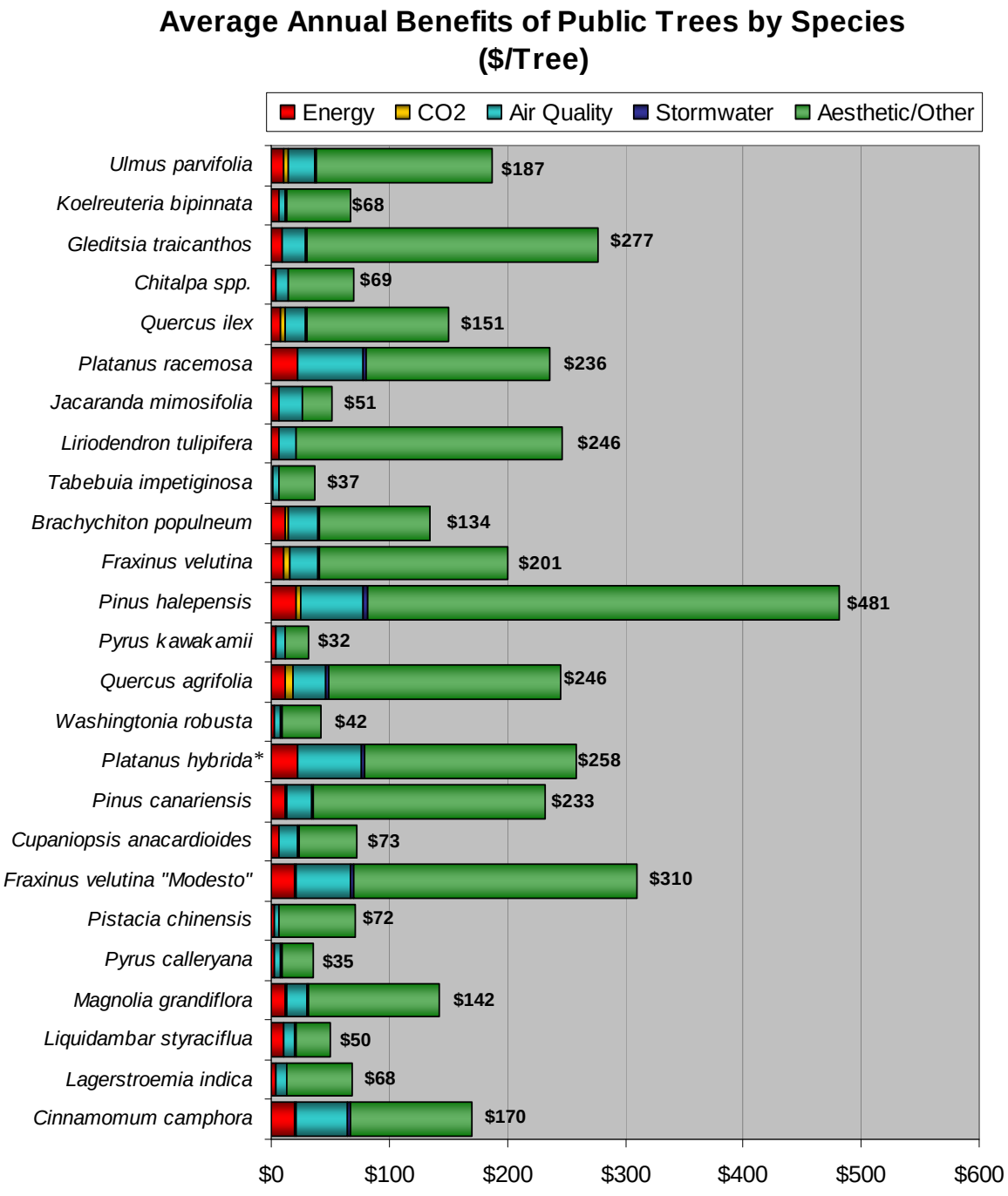


Figure 10. Top Five Tree Species for Increasing Aesthetic Benefits in Burbank.

Table 11. Annual Aesthetic/Other Benefits of Burbank's Public Trees.

Species	Total ($)	% of Total Tree Population	% of Total $	Avg. $/tree
Cinnamomum camphora	**449,137**	13.54	14.06	**103.39**
Lagerstroemia indica	**184,331**	10.38	5.77	**55.35**
Liquidambar styraciflua	**70,320**	7.37	2.20	**29.73**
Magnolia grandiflora	**236,783**	6.68	7.41	**110.49**
Pyrus calleryana	**32,867**	3.91	1.03	**26.19**
Pistacia chinensis	**73,406**	3.53	2.30	**64.85**
Fraxinus velutina "Modesto"	**262,403**	3.41	8.21	**240.08**
Cupaniopsis anacardioides	**52,131**	3.27	1.63	**49.65**
Pinus canariensis	**178,815**	2.84	5.60	**196.50**
Platanus hybrida	**156,614**	2.72	4.90	**179.19**
Washingtonia robusta	**26,793**	2.55	0.84	**32.75**
Quercus agrifolia	**152,389**	2.41	4.77	**197.40**
Pyrus kawakamii	**12,912**	2.06	0.40	**19.50**
Pinus halepensis	**212,909**	1.66	6.66	**399.45**
Fraxinus velutina	**79,254**	1.55	2.48	**159.46**
Brachychiton populneum	**45,819**	1.53	1.43	**93.32**
Tabebuia impetiginosa	**14,544**	1.51	0.46	**30.11**
Liriodendron tulipifera	**107,576**	1.49	3.37	**225.05**
Jacaranda mimosifolia	**11,238**	1.44	0.35	**24.27**
Platanus racemosa	**64,384**	1.29	2.02	**155.14**
Quercus ilex	**48,640**	1.26	1.52	**120.40**
Chitalpa spp.	**19,816**	1.13	0.62	**54.44**
Gleditsia traicanthos	**89,243**	1.13	2.79	**247.21**
Koelreuteria bipinnata	**19,241**	1.09	0.60	**54.82**
Ulmus parvifolia	**50,081**	1.06	1.57	**147.73**
Other street trees	**542,870**	19.17	16.99	**88.27**
Citywide Total	**3,194,514**	**100.00**	**100.00**	**99.59**



**Platanus hybrida, a.k.a. Platanus acerifolia (USDA Plant Database and STRATUM)*

Figure 11. Average Annual Per Speciel Benefits of Burbank's Public Trees.

Net Benefits and Benefit-Cost Ratio (BCR)

Burbank receives substantial benefits from its public trees; however, the city must also consider the costs of maintaining this resource. Applying a *benefit-cost ratio* (BCR) is a useful way to evaluate the public investment in the street tree population. A BCR is an indicator used to summarize the overall value compared to the costs of a given project. Specifically in this analysis, BCR is the ratio of the cumulative benefits provided by the city's street trees expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

Burbank's municipal trees have beneficial effects on the environment. Greater than 25% (over one million dollars) of the total annual benefits quantified in this study are environmental services (Table 12). Air quality benefits ($687,571) account for 63% of the annual environmental benefits and 16% of all benefits. Energy savings ($235,741) account for 21.6% of the annual environmental benefits and 5.5% of all annual benefits. The reduction of stormwater runoff (3.8%) and CO_2 reduction (3.5%) provide the balance of annual environmental benefits. Annual increases in property value and other aesthetic values are substantial benefits, accounting for 75% of the total benefits.

Table 12. Benefit–Cost Summary for Burbank's Public Trees.

Benefit	Total ($)	$/tree	$/capita
Energy	325,741	10.15	3.25
CO2	37,942	1.18	0.38
Air Quality	687,571	21.44	6.87
Stormwater	41,081	1.28	0.41
Aesthetic/Other	3,194,514	99.59	31.91
Total Benefits	4,286,849	133.64	42.83
Expenditure			
Planting	12,412	0.39	0.12
Pruning	304,183	9.48	3.04
Pest Management	10,000	0.31	0.10
Irrigation	26,000	0.81	0.26
Removal	63,212	1.97	0.63
Administration	241,176	7.52	2.41
Inspection/Service	1,468	0.05	0.01
Infrastructure Repairs	1,000,000	31.17	9.99
Litter Clean-up	36,521	1.14	0.36
Liability/Claims	138,000	4.30	1.38
Other Costs	9,124	0.28	0.09
Total Costs	1,842,096	57.43	18.40
Net Benefits	**2,444,753**	**76.22**	**24.42**
Benefit-Cost Ratio	**2.327157974**		

The sum of estimated benefits for Burbank's public tree resource is $4.3 million; that is a value of $134 per street tree and $42.83 per capita. These benefits are realized on an annual basis. It should be understood that this is not a full accounting of the benefits provided by Burbank's public trees since some benefits are intangible and/or difficult to quantify, such as impacts on psychological health, crime, and violence. Empirical evidence of these benefits does exist, but there is limited knowledge about the physical processes at work and their interactions make quanitification imprecise. Tree growth and mortality rates are highly variable. A true and full accounting of benefits and costs must consider variability among sites (e.g., tree species, growing conditions, maintenance practices) throughout the city, as well as variability in tree growth. In other words, trees are worth far more than what we can ever quantify!

The total annual benefit that trees provide to the City of Burbank is approximately $4.3 million. When the city's annual tree-related expenditures of $1.8 million are considered, the net annual benefit (benefits minus costs) to the city is $2.4 million. The average net benefit for an individual street tree in Burbank is $76, and the per capita benefit is $24. Based on the inventory count of 32,077 public trees, Burbank receives $2.33 in benefits for every $1 that is spent on its municipal forestry program (Table 12). Proper maintenance and regular pruning are critical to maintaining Burbank's public trees and the current level of benefits they are providing. Appropriate management strategies can make a huge difference between a fully functional public tree and a public liability.

Total Annual Cost of Burbank's Community Forest

$1.8 Million

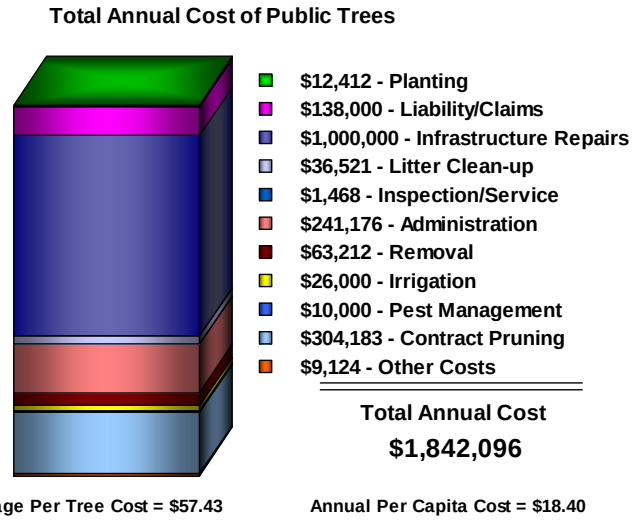


Figure 12. Total Annual Cost of maintaining Burbank's community forest

Total Annual Benefits of Burbank's Community Forest

$4.3 Million

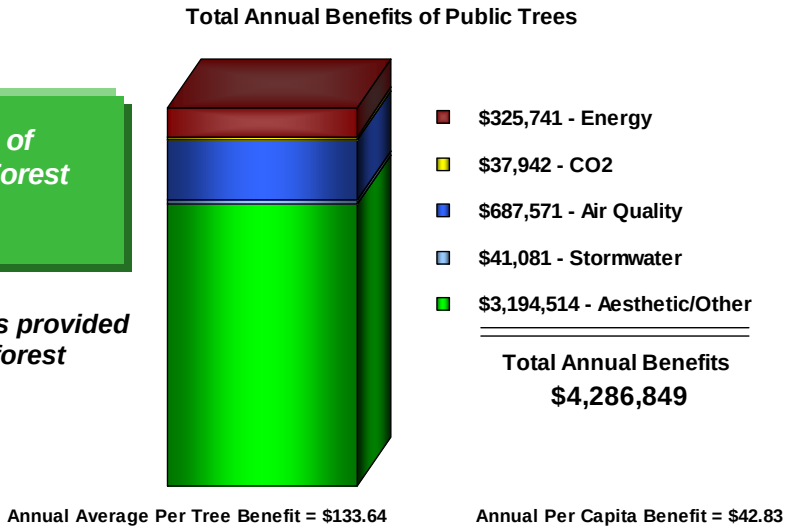


Figure 13. Total Annual Benefits provided by Burbank's community forest

Net Benefits
$2.4 Million

For every $1 spent on the community forest, Burbank receives $2.33 in benefits

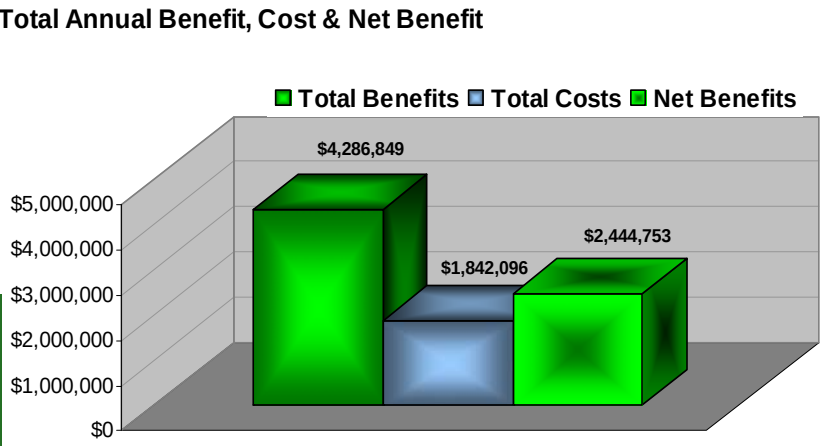


Figure 14. Total Annual Benefits, Cost, and Net Benefits of Burbank's Community Forest.

Chapter 4: Investing in Burbank's Municipal Trees

The community forest is one of the few municipal assets that has the potential to increase in value with time and proper management.

Maintaining an urban forest is an investment in the community. The return on that investment is realized through the ecological, psychological, social, and economic benefits that trees provide. This chapter presents a breakdown of the city's current annual investment as well as the current *benefit-cost ratio* (an indicator of the value of an investment) for maintaining Burbank's community forest .

Burbank's annual tree-related expenditures total approximately $1.8 million. Based on information provided by the City (Williams, 2008), Burbank spends an average of $57.43 per public tree and approximately $18.40 per capita. The city's park, recreation, and community services department is responsible for the care and management of public trees, as well as for new and replacement tree planting. It may be difficult to determine what percentage of the department's budget is solely dedicated to the maintenance of street trees. Per tree and per capita spending on street trees in Burbank may be overstated. (i.e., some dollars spent on infrastructure repairs may not be related to trees, etc.).

Expenditures pertaining to the municipal forest generally fall into three main categories: tree planting and establishment, maintenance, and administration.

Burbank's $12,000 tree planting budget funds approximately 150 new trees annually.

Tree Planting and Establishment

Quality nursery stock, careful planting, and follow-up care are critical to the long term survival of newly planted trees and for maintaining a stable urban forest. Burbank's estimated annual tree purchasing and planting expenditures are approximately $12,000. One program, which provides 100 to 150 trees annually, allows residents to request that a street tree be planted adjacent to their property. The trees (generally size #15) are planted and pruned by the Park, Recreation and Community Services Department. Depending upon requests, additional trees may be planted in residential or business districts where there is a desire or request for trees. Whenever a tree must be removed, it is the policy of the department to replace that tree in the landscape.

The sustainability of Burbank's urban forest and the benefits it provides require ongoing investment in planting and tree replacement. Continuing to fund citywide street tree planting, in addition to existing tree maintenance, should remain a goal. In many municipal urban forestry programs, partnerships with local non-profit organizations and other city departments can be instrumental in applying expertise, funding, and manpower to a successful tree planting and establishment program. For example, non-profits are typically an excellent resource for organizing volunteers and canvassing neighborhoods for potential planting sites, assisting with tree planting, and, in some instances, performing new tree maintenance activities such as mulching, watering, and light pruning.

Maintenance

Tree pruning is the responsibility of the Park, Recreation, and Community Services Department. Currently, there is no scheduled pruning program and Burbank's street trees are trimmed on an as needed basis, generally at the request of a resident. The forestry staff is also responsible for pruning the trees in public parks.

Maintenance activities including pruning, pest management, irrigation, removals, and litter clean-up, cost the City of Burbank an estimated $440,000 annually, or approximately 24% of the total urban forest expenditures. Pruning accounts for the majority of the city's maintenance expenditures ($304,000), 16.5% of total cost, and 69% of all maintenance activity, followed by removals at $63,000 (3% of total cost).

Administration

Administration costs associated with caring for Burbank's urban forest are estimated to be $243,000 (13.2% of total costs), including the salaries of supervisory and clerical staff, equipment, supplies, training, site inspections, and service calls.

Burbank's tree inventory is maintained by the urban forestry staff using TreeKeeper® 7.6, an urban forestry management system developed by Davey to provide accurate and dependable inventory data specific to tree characteristics, performed maintenance, and tree health.

Planning and funding for care and management must complement tree planting efforts in order to ensure long term success.

Additional Tree-Related Expenditures

Annual tree-related expenditures, such as infrastructure repair related to tree/hardscape conflicts cost the City of Burbank an estimated annual amount of $1 million, or 54% of total expenditures. Trip-and-fall claims, property damage payments, and legal staff time required to process tree-related claims can be substantial in cities like Burbank. Average annual expenditures related to tree-related liability, claims, and payments were estimated at approximately $138,000 (Glen Williams, 2008), or 7.5% of the City's total tree-related expenditures.

Infrastructure repairs due to shallow roots that heave sidewalks, crack curbs, and damage driveways are a critical part of municipal tree care. Burbank is encouraged to consider solutions that minimize damage to the tree, such as ramping sidewalks over shallow roots or grinding down lifted concrete. Additionally, the cost of repairs may by further reduced through careful planning and species selection, as well as exploring alternative surface solutions and structural soils for new planting sites.

Chapter 5: Management Implications

Understanding the value and overall performance of Burbank's community forest is the first step in developing a community forest master plan. This study provides a "snapshot" in time of the urban forest resource. This report shows that money spent on planting and caring for Burbank's trees is a wise investment. It also serves as an opportunity to speculate about the future. Given the status of the city's tree population, what future trends are likely and what management challenges will need to be met to sustain, or more importantly, increase the level of benefits? The information in this study should be used as a tool when making management and policy decisions regarding Burbank's public trees and their care.

Understanding the value and overall performance of Burbank's community forest is the first step in developing a community forest master plan.

Burbank has taken a proactive stance on conservation and sustainability, pledging to reduce greenhouse gas emissions and combating the effects of climate change by joining with 500 other cities nationwide in striving to reduce global warming pollution by their commitment to the U. S. Mayors Climate Protection Agreement. Under this agreement, participating communities are encouraged to meet Kyoto Protocol targets, specifically, the reduction of greenhouse gas emission in the United States by 7% (to 1990 levels) by 2012. Action items include anti-sprawl land-use polices, public information campaigns, and urban forest restoration projects. Maintaining a vital and sustainable urban forest is a direct and tangible way that Burbank can help meet these commitments. The city's street tree resource represents a large part of the overall effort to improve the environment and the community. Achieving urban forest resource sustainability and increasing overall benefits to the community through the development of sound maintenance policies maximizes the health and utility of Burbank's community forest.

Resource Trends and Challenges

Canopy cover or, more precisely, the amount and distribution of leaf surface area, is the driving force behind the urban forest's ability to produce benefits for the community (Clark, 1997). As canopy cover increases, so do the benefits afforded by leaf area. Maximizing the return on this investment is contingent upon maximizing and maintaining the quality and extent of Burbank's canopy cover through optimum stocking level.

Stocking Level

Burbank's current stocking level is estimated to be 46.5%. Although this is above the mean stocking level (38.4%) for 22 U. S. cities (McPherson and Rowntree, 1989), it indicates that Burbank is utilizing less than half of the potential planting sites and would need to plant an additional 33,900 trees to reach a 100% stocking level. While this may not be a true reflection of exactly how many planting sites are available depending on planting space, proximity to existing privately-owned trees, and utility conflicts, it nevertheless suggests that a great deal of available space exists. Identifying potential planting sites and developing an annual goal and budget for maximizing the stocking level should be a next step.

Canopy Cover

Burbank's street tree canopy is estimated to cover 331 acres (3%) of the total land area of 11,008 acres (17.2 square miles) and 9.8% of the total street and sidewalk area (1,673 acres) within the city. The amount and distribution of leaf surface area is the driving force behind the urban forest's ability to produce benefits for the community. As canopy cover increases, so do the benefits! **Burbank should set a goal and a proposed timeline for increasing canopy coverage, thereby increasing the environmental benefits of its community forest.** Selecting the most appropriate species for each available planting site will lead to maximum possible canopy coverage for Burbank's future.

Large-Stature Trees Versus Small-Stature Trees

Numerous considerations drive species choice, including planting site conditions, potential conflicts with infrastructure, maintenance concerns, and design considerations. In some cases, small- or medium-stature trees are the best (or only) option. Nonetheless, the results of this analysis emphasize that **large-growing trees should be planted and replaced wherever possible to increase the benefits realized and the return on investment from the city.** Large trees provide the most benefits, and average annual benefits increase with mature tree size.

The city relies on its large-stature trees (broadleaf deciduous, large-growing trees) to provide the most benefits. Emphasis should be placed on identifying existing planting space suitable for new large-stature trees. While large trees may be associated with higher maintenance costs over time compared to smaller trees, implementing a new tree establishment program and a proactive young tree training pruning program can help distribute those costs more evenly and protect the initial investment of planting while ensuring maximum benefits are provided to the community.

Burbank's street tree canopy is estimated to cover 331 acres (3%) of the total land area of 11,008 acres (17.2 square miles) and 9.8% of the total street and sidewalk area (1,673 acres) within the city.

Chapter 6: Conclusion

This analysis describes the structural characteristics of Burbank's public tree resource and uses STRATUM to determine the environmental and aesthetic benefits provided to the city and its residents. From this, a benefit-cost ratio has been derived and some management goals have been suggested. The approach is based on established tree sampling, numerical modeling, and statistical methods, and provides a general accounting of the benefits produced by Burbank's public trees. This information can be used to make informed management decisions regarding the current status of the city's forestry program and the resource it maintains. Future changes and improvements to the community forestry program should be directed towards sustainability and increasing both cost-effectiveness and overall benefits. Burbank's urban forest would benefit from the development of a comprehensive management plan.

When evaluating the bottom line, Burbank's trees are worth the management investment. The public tree resource gives back more than double the community investment in terms of stormwater runoff reductions, energy savings, atmospheric CO_2 reductions, and other benefits. The city's 32,077 public trees are a valuable asset, providing approximately $4.3 million ($134 per tree) in annual gross benefits. Taking into account the costs to manage this resource, Burbank's trees provide $2.4 million ($76 per tree) in net annual benefits. **The Burbank community receives a great return on investment, with every $1 spent on the municipal forest providing $2.33 in benefits.**

Obtaining an inventory of Burbank's community forest allows urban forest managers and forestry personnel to track individual trees and the resources, inspection records, and maintenance activities specific to each tree. An inventory is an invaluable tool for recordkeeping and front line management decisions, as well as an important component of a comprehensive urban forest management program.

Combining Burbank's tree inventory with i-tree's STRATUM software provides valuable data necessary for complete urban forest resource analysis. This resource analysis examines trends and performance measures over the entire community forest and each of the major species populations within. Rather than examining each individual tree as an inventory does, resource analysis examines the entire urban forest system as a whole, quantifying the value, benefits, and performance of the communities trees as they perform at the urban forest level. A community forest resource analysis provides urban forest managers and key decision-makers with invaluable information for the long range decision-making and policy development necessary for ensuring sustainability of the community forest.

Information from a community forest resource analysis can be used to create an urban forest management plan. Performance data from the analysis should be used to make determinations regarding species, selection, distribution, and maintenance policies. Structural data is necessary for establishing goals and performance objectives and may be used as a benchmark for measuring future success. An urban forest management plan is a critical tool for successful urban forest management, inspiring commitment and providing vision for communication with key decision-makers both inside and outside the organization.

Recommendations Derived From This Analysis

- Expand new tree planting programs and funding for establishment, based on determination of reasonable goals for increasing canopy coverage and stocking levels, as well as improving relative age distribution in valued species.
- Increase total canopy cover, thus increasing the environmental benefits afforded by leaf area.
- Diversify species through new tree plantings, focusing on underutilized but good performing species (RPI > 1.0), reducing dependence on camphor (*Cinnamomum camphora*) and guarding against possible catastrophic losses.
- Select large-stature species for new planting wherever possible to increase the benefits realized and the return on the community investment.
- Promote an uneven distribution of relative ages in the street tree population through new tree plantings and appropriate species selection, ensuring a stable population and flow of benefits over time.
- Establish a citywide, cyclical pruning program aimed at increasing overall benefits and effectively mitigating developing safety risks. Regular pruning is especially important for young urban trees. Appropriate young tree structural pruning can dramatically reduce the need for heavy mature tree pruning, which tends to generate high amounts of debris for disposal and can be detrimental to tree health.
- Explore use of structural soils, rerouting sidewalks around root flares, and expanding growing space sizes wherever possible to improve cost-effectiveness associated with infrastructure conflicts.
- Continue to utilize TreeKeeper® to manage the public tree inventory and to track maintenance activities. Comprehensive tree care and management data is essential for future resource analysis, budgeting, and policy development.

Managers of the urban forest and the community can take pride in knowing that public trees substantially improve the quality of life in Burbank. Urban trees require sound maintenance to sustain their ability to provide benefits back to the community and to remain economically viable in the scheme of municipal management. The magnitude of benefits related to environmental sustainability provide a compelling argument for continual tree care and resource management. The magnitude of benefits related to employment opportunities, job training, community building, reduced violence, and enhanced human health and well-being can also be substantial. Moreover, these benefits extend beyond the site where trees are planted, furthering collaborative efforts to build better communities.

Appendix A: Methods and Procedures

The City of Burbank contracted with Davey Resource Group (DRG) in 1999 to conduct a street tree inventory. The inventory is maintained by the urban forestry staff using TreeKeeper® 7.6, an urban forestry management system developed by Davey to provide accurate and dependable inventory data specific to tree characteristics, maintenance performed, and health.

In October 2007, Davey Resource Group conducted an inventory of the City of Burbank's park tree resources. The inventory consisted of all city-managed parks, playgrounds, and the City Public Works Yard, but excluded golf courses as they are not managed by the Department of Parks and Recreation. Only trees that had the potential to affect users of Wildwood Canyon Park were inventoried. Those that exist in the non-maintained areas of the preserve were not included in the inventory at the request of the City. In total, 3,658 trees in 27 separate areas were inventoried.

Table 13 - Tree Count by Park.

Park	Count
Abraham Lincoln Park	171
Bel Aire Park	70
Brace Canyon Park	360
Chandler Bikeway	242
Compass Tree Park	4
Earthwalk Park	17
George Izay Park	261
Johnny Carson Park	266
Maple Street Playground	19
McCambridge Park	548
Miller Park	25
Mountain View Park	62
Pacific Park	124
Palm Park	3
Public Works Department Yard	23
Ralph Foy Park	166
Robert E. Gross Park	53
Robert E. Lundigan Park	18
Santa Anita Playlot	9
Starlight Bowl	171
Stough Canyon Park	58
Valley Park Skate Park	93
Verdugo Park & Rec Center	154
Vickroy Park	31
Whitnall Highway Park North	96
Whitnall Highway Park South	94
Wildwood Canyon Park	520
TOTAL	**3658**

The Park tree inventory utilized two inventory arborists electronically inputting data using proprietary Davey Work Planning Software. The data was uploaded into the Davey TreeKeeper® inventory management system already in use by the city. A major improvement over the previous inventory conducted on street trees is that the park tree inventory utilized GPS locations and GIS data map layers to provide accurate spatial locations of the trees. This allows the city to view and identify tree locations from either in the office or in the field using TreeKeeper® and print maps if necessary for maintenance activities to be conducted on identified trees. This added feature required an upgrade to the city's TreeKeeper® system to version 7.6 which allows for the use of the GIS data.

In October 2007, Davey Resource Group conducted an inventory of the City of Burbank's park tree resources.

Attributes for the Park tree inventory mimicked the street tree inventory already in place, but also included additional fields for an anticipated STRATUM analysis of the park trees. When an initial projection of 6,000 trees to be identified was found to be closer to 3,500, budgetary allowances already in place for the project allowed for a STRATUM analysis to be conducted for the entire city urban forest assets, not just the park trees.

Table 14 - Park Tree Attributes Collected.

Attribute
Planter Type
Species
DBH
Stem Count
Height
Canopy Width
Trunk Condition
Foliage Condition
Maintenance Requirement
Priority Task
Hardscape Damage
Overhead utility conflicts

In April 2008, Davey Resource Group obtained the latest inventory database from the City. 32,077 public trees were included in this analysis. Stumps, vacant planting sites, and private trees are excluded. The inventory data can be obtained from the Burbank TreeKeeper® management system.

Burbank's tree inventory data was formatted for use in i-Tree's street tree population assessment tool, STRATUM (Version 3.2, Build 3). STRATUM assesses tree population structure and the function of those trees, such as their role in building energy use, air pollution removal, stormwater interception, carbon dioxide removal, and property value

increases. In order to analyze the economic benefits of Burbank's public trees, STRATUM assigns a dollar value to the annual resource functionality and compares that to annual program expenditures. This analysis combines the results of the city's street tree inventory with benefit-cost modeling data to produce information regarding resource structure, resource function, and resource value to make resource management recommendations. STRATUM regionalizes the calculations of its output by incorporating detailed reference city project information for 17 climate zones across the United States. Burbank is located in the Inland Empire Climate Zone .

For each of the modeled benefits, an annual resource unit was determined on a per tree basis. Resource units are measured as MWh of electricity saved per tree; MBtu of natural gas conserved per tree, pounds of atmospheric CO_2 reduced per tree; pounds of NO_2, PM_{10}, and VOCs reduced per tree; cubic feet of stormwater runoff reduced per tree; and square feet of leaf area added per tree to increase property values.

Prices were assigned to each resource unit using economic indicators of society's willingness to pay for the environmental benefits trees provide. Estimates of benefits are initial approximations as some benefits are difficult to quantify (e.g., impacts on psychological health, crime, and violence). In addition, limited knowledge about the physical processes at work and their interactions makes estimates imprecise (e.g., fate of air pollutants trapped by trees and then washed to the ground by rainfall). Therefore, this method of quantification provides first-order approximations. It is meant to be a general accounting of the benefits produced by urban trees—an accounting with an accepted degree of uncertainty that can, nonetheless, provide science-based platform for decision-making.

Table 14 - Burbank's Benefit Prices Used in this Analysis.

Benefits	Price	Unit	Source
Electricity	$.16218	$/Kwh	STRATUM default- Inland Empire
Natural Gas	$1.31	$/Therm	STRATUM default- Inland Empire
CO_2	$0.015	$/lb	STRATUM default- Inland Empire
PM_{10}	$51.32	$/lb	STRATUM default- Inland Empire
NO_2	$16.44	$/lb	STRATUM default- Inland Empire
SO_2	$21.47	$/lb	STRATUM default- Inland Empire
VOC	$3.34	$/lb	STRATUM default- Inland Empire
Stormwater Interception	$0.00183	$/gallon	STRATUM default- Inland Empire
Average Home Resale Value	$524,500	$	STRATUM default- Inland Empire

STRATUM's default values (Table 14) from the Inland Empire Climate Zone were used for all benefit prices (air quality, stormwater, aesthetic/other). Using these prices, the magnitude of the benefits provided by the street tree resource was calculated using STRATUM. For a detailed description of how the magnitudes of benefit prices are calculated, refer to the the Tree Guidelines for Inland Empire Communities (McPherson and others, 2001).

Appendix B: Additional STRATUM Output Reports

Table 15 - Frequency of Tree Species by DBH Class and Tree Type.

Species	DBH Class (in)									
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Broadleaf Deciduous Large (BDL)										
Fraxinus velutina "Modesto"	4	13	312	416	253	72	22	1	0	1,093
Platanus hybrida	28	49	80	225	273	156	47	16	0	874
Liriodendron tulipifera	180	118	125	54	1	0	0	0	0	478
Platanus racemosa	13	3	57	98	86	92	54	11	1	415
Gleditsia traicanthos	27	95	212	26	0	1	0	0	0	361
Catalpa speciosa	0	0	11	19	44	28	16	0	0	118
Ulmus americana	1	0	0	6	12	19	29	4	6	77
Morus alba	4	8	17	15	4	3	0	0	0	51
Acer saccharinum	1	3	3	6	7	17	7	1	1	46
Robinia pseudoacacia	3	5	6	8	8	3	1	0	0	34
Fraxinus americana	3	0	8	3	9	2	0	0	0	25
Juglans nigra	7	2	0	1	3	1	1	0	1	16
Acer negundo	1	1	3	2	3	2	2	1	0	15
Platanus occidentalis	1	0	0	0	0	1	5	5	0	12
Carya illinoinensis	0	0	2	4	1	1	0	0	0	8
Juglans hindsii	0	0	0	4	1	1	0	1	0	7
Acer palmatum	3	1	0	1	0	0	0	0	0	5
Acer species	1	0	0	2	1	0	0	0	0	4
Catalpa spp.	0	1	0	0	1	0	0	0	0	2
Quercus rubra	1	0	0	1	0	0	0	0	0	2
Celtis species	0	0	1	0	0	0	0	0	0	1
Populus alba	0	0	0	1	0	0	0	0	0	1
Zelkova serrata	0	0	1	0	0	0	0	0	0	1
Total	**278**	**299**	**838**	**892**	**707**	**399**	**184**	**40**	**9**	**3,646**
Broadleaf Deciduous Medium (BDM)										
Liquidambar styraciflua	21	76	434	1,039	603	174	17	1	0	2,365
Pistacia chinensis	461	380	279	11	0	0	1	0	0	1,132
Koelreuteria bipinnata	82	51	122	91	5	0	0	0	0	351
Sophora japonica	91	100	35	0	0	0	0	0	0	226
Brachychiton acerifolium	0	10	39	29	2	0	0	0	0	80
Liquidambar formosana	9	15	1	4	6	1	0	0	0	36
Salix spp.	7	7	19	1	1	0	0	0	0	35
Koelreuteria paniculata	12	14	7	0	1	0	0	0	0	34
Melia azedarach	1	1	5	11	8	3	4	1	0	34
Ginkgo biloba	23	2	4	3	0	0	0	0	0	32
Betula pendula	7	14	8	1	0	0	0	0	0	30
Juglans regia	1	1	3	5	1	7	2	2	1	23
Paulownia tomentosa	1	1	10	2	2	1	1	1	0	19
Alnus cordata	0	0	5	10	2	0	0	0	0	17
Fraxinus pennsylvanica	0	0	1	1	7	2	1	0	0	12
Ailanthus altissima	0	4	2	2	3	0	0	0	0	11
Alnus rhombifolia	0	0	1	5	2	0	0	0	0	8
Fraxinus spp.	0	0	3	0	0	0	0	0	0	3
Broussonetia papyrifera	0	0	0	1	1	0	0	0	0	2
Triadica sebifera	1	0	0	0	0	0	0	0	0	1
Total	**717**	**676**	**978**	**1,216**	**644**	**188**	**26**	**5**	**1**	**4,451**
Broadleaf Deciduous Small (BDS)										
Lagerstroemia indica	1,114	1,548	656	8	0	1	3	0	0	3,330
Jacaranda mimosifolia	50	50	120	146	84	10	3	0	0	463
Chitalpa spp.	113	147	104	0	0	0	0	0	0	364
Prunus cerasifera	117	65	5	0	0	0	0	0	0	187
Bauhinia variegata	33	32	21	2	0	0	0	0	0	88
Machaerium tipu	3	5	23	2	2	1	1	0	0	37
Albizia julibrissin	3	8	23	1	1	0	0	0	0	36
Magnolia x soulangiana	28	1	2	1	0	0	0	0	0	32
Malus spp.	8	10	9	0	0	0	0	0	0	27
Cercis canadensis	16	1	3	0	0	0	0	0	0	20
Persea americana	2	2	1	6	3	0	0	0	0	14
Prunus armeniaca	1	5	4	1	0	0	0	0	0	11
Rhus spp.	0	2	7	2	0	0	0	0	0	11

Prunus domestica	8	0	0	0	0	0	0	0	0	8
Prunus persica	5	2	0	0	0	0	0	0	0	7
Ficus carica	4	0	0	0	0	0	0	0	0	4
Prunus species	1	2	0	0	0	0	0	0	0	3
Celtis reticulata	0	0	0	1	1	0	0	0	0	2
Acer buergeranum	0	0	1	0	0	0	0	0	0	1
Cercis reniformis	1	0	0	0	0	0	0	0	0	1
Punicia granatum	0	0	1	0	0	0	0	0	0	1
Total	**1,507**	**1,880**	**980**	**170**	**91**	**12**	**7**	**0**	**0**	**4,647**
Broadleaf Evergreen Large (BEL)										
Quercus agrifolia	48	38	88	136	220	149	78	14	1	772
Fraxinus velutina	1	1	94	200	128	58	14	1	0	497
Quercus ilex	7	24	124	171	61	13	4	0	0	404
Ulmus parvifolia	6	21	41	117	139	12	3	0	0	339
Podocarpus gracilior	34	48	118	43	3	0	0	0	0	246
Fraxinus uhdei	6	10	27	54	45	19	9	2	0	172
Eucalyptus citriodora	3	5	26	36	8	6	0	0	0	84
Eucalyptus sideroxylon	0	6	17	21	18	15	1	0	0	78
Eucalyptus rudis	0	10	14	26	13	3	0	0	0	66
Eucalyptus camaldulensis	3	3	16	21	12	6	1	1	1	64
Eucalyptus polyanthemos	1	3	8	21	15	8	2	2	1	61
Eucalyptus ficifolia	0	0	6	5	18	8	6	3	2	48
Eucalyptus globulus	10	0	0	5	3	8	4	3	1	34
Grevillea robusta	0	1	0	0	8	11	7	0	0	27
Ulmus pumila	1	2	4	5	6	5	4	0	0	27
Eucalyptus viminalis	1	1	1	0	3	2	6	4	4	22
Quercus spp.	0	0	7	6	2	0	0	0	0	15
Quercus virginiana	0	3	7	1	0	0	0	0	0	11
Acacia melanoxylon	0	0	2	2	1	3	1	0	0	9
Eucalyptus cladocalyx	0	2	3	1	0	0	0	2	0	8
Quercus lobata	0	0	6	1	0	0	0	1	0	8
Quercus suber	3	4	0	0	0	0	0	0	0	7
Erythrina coralloides	0	0	0	3	0	0	0	0	0	3
Eucalyptus species	0	0	0	0	0	3	0	0	0	3
Casimiroa edulis	0	0	1	0	1	0	0	0	0	2
Erythrina caffra	0	0	0	0	1	0	0	0	0	1
Quercus kelloggii	1	0	0	0	0	0	0	0	0	1
Total	**125**	**182**	**610**	**875**	**705**	**329**	**140**	**33**	**10**	**3,009**
Broadleaf Evergreen Medium (BEM)										
Cinnamomum camphora	46	60	512	1,336	1,373	613	293	93	18	4,344
Magnolia grandiflora	88	172	798	797	226	54	7	1	0	2,143
Brachychiton populneum	6	12	207	208	43	15	0	0	0	491
Ficus retusa ssp nitida	8	7	23	138	117	26	0	0	0	319
Ceratonia siliqua	1	0	6	21	58	36	29	10	2	163
Ligustrum lucidum	4	9	70	30	0	0	0	0	0	113
Calodendrum capense	27	17	1	5	0	0	0	0	0	50
Schinus molle	2	17	7	10	0	5	1	3	4	49
Melaleuca quinquenervia	8	6	18	2	2	6	4	0	0	46
Ficus benjamina	8	9	20	0	2	0	0	0	0	39
Eucalyptus nicholii	2	2	5	11	5	1	0	0	0	26
Pittosporum rhombifolium	0	4	13	3	0	0	0	0	0	20
Eucalyptus leucoxylon	0	2	4	8	4	0	0	0	0	18
Acacia species	3	1	7	4	0	0	0	0	0	15
Ficus rubiginosa	0	3	8	0	1	1	0	0	0	13
Pittosporum undulatum	3	5	0	1	0	0	0	0	0	9
Syzygium paniculatum	0	3	4	1	0	0	0	0	0	8
Pittosporum tobira	0	3	4	0	0	0	0	0	0	7
Acacia baileyana	2	3	1	0	0	0	0	0	0	6
Ficus elastica	2	2	0	2	0	0	0	0	0	6
Magnolia spp.	6	0	0	0	0	0	0	0	0	6
Pittosporum viridiflorum	0	0	3	1	2	0	0	0	0	6
Chorisia speciosa	1	0	1	1	0	0	1	0	0	4
Eucalyptus cinerea	1	1	0	1	0	0	0	0	0	3
Acacia decurrens	1	0	1	0	0	0	0	0	0	2
Eucalyptus torquata	0	1	0	0	0	0	0	0	0	1
Total	**219**	**339**	**1,713**	**2,580**	**1,833**	**757**	**335**	**107**	**24**	**7,907**
Broadleaf Evergreen Small (BES)										
Pyrus calleryana	428	359	374	89	5	0	0	0	0	1,255
Cupaniopsis anacardioides	161	199	453	223	13	1	0	0	0	1,050

Pyrus kawakamii	79	169	327	87	0	0	0	0	0	662
Tabebuia impetiginosa	236	110	127	10	0	0	0	0	0	483
Cassia leptophylla	149	78	30	0	0	0	0	0	0	257
Tristaniopsis conferta	63	48	120	25	1	0	0	0	0	257
Geijera parviflora	72	52	51	22	1	0	0	0	0	198
Callistemon citrinus	10	50	95	3	0	0	0	0	0	158
Podocarpus macrophyllus	2	46	85	6	0	0	0	0	0	139
Hymenosporum flavum	51	33	28	0	0	0	0	0	0	112
Arbutus unedo	100	0	3	0	1	0	0	0	0	104
Prunus caroliniana	3	2	22	36	13	7	0	0	0	83
Agonis flexuosa	31	17	27	2	0	1	0	0	0	78
Rhus lancea	0	0	13	29	5	0	0	0	0	47
Olea europaea	2	2	11	20	6	4	0	0	0	45
Callistemon viminalis	12	7	16	8	1	0	0	0	0	44
Schinus terebinthifolius	3	4	10	14	9	2	1	0	0	43
Nerium oleander	18	9	10	4	0	0	0	0	0	41
Ilex altaclarensis	6	12	14	1	0	0	0	0	0	33
Eriobotrya deflexa	2	6	19	0	0	0	0	0	0	27
Citrus spp.	6	10	8	0	0	0	0	0	0	24
Stenocarpus sinuatus	14	9	1	0	0	0	0	0	0	24
Photinia x fraseri	3	10	6	1	0	0	0	0	0	20
Eriobotrya japonica	12	6	1	0	0	0	0	0	0	19
Tristaniopsis laurina	4	4	7	2	1	0	0	0	0	18
Dodonaea viscosa	0	4	1	0	0	0	0	0	0	5
Heteromeles arbutifolia	0	0	1	1	0	0	0	0	0	2
Melaleuca linariifolia	0	0	1	1	0	0	0	0	0	2
Annona cherimola	1	0	0	0	0	0	0	0	0	1
Feijoa sellowiana	1	0	0	0	0	0	0	0	0	1
Leptospermum laevigata	0	0	0	0	0	1	0	0	0	1
Macadamia tetraphylla	0	1	0	0	0	0	0	0	0	1
Total	**1,469**	**1,247**	**1,861**	**584**	**56**	**16**	**1**	**0**	**0**	**5,234**
Conifer Evergreen Large (CEL)										
Pinus canariensis	37	44	161	287	178	160	40	3	0	910
Pinus halepensis	6	8	85	139	93	73	81	35	13	533
Cupressus sempervirens	3	13	33	4	15	7	2	0	0	77
Casuarina equisetifolia	0	0	0	16	30	11	4	1	0	62
Pinus pinea	5	3	14	7	4	4	9	3	8	57
Pinus radiata	4	1	4	5	11	19	2	2	0	48
Casuarina cunninghamiana	2	0	2	11	17	9	0	0	0	41
Cedrus deodara	2	4	8	12	4	3	3	2	0	38
Sequoia sempervirens	0	2	19	5	1	2	1	0	0	30
Araucaria heterophylla	3	13	7	1	0	0	0	0	0	24
Calocedrus decurrens	1	1	1	3	2	4	0	0	0	12
Pinus coulteri	1	0	1	2	3	3	2	0	0	12
Pinus spp.	1	0	5	4	0	0	0	0	0	10
Cupressus species	0	0	1	1	1	0	0	0	0	3
Araucaria araucana	1	0	1	0	0	0	0	0	0	2
Sequoiadendron giganteum	0	1	0	0	0	0	1	0	0	2
Pinus torreyana	0	0	1	0	0	0	0	0	0	1
Total	**66**	**90**	**343**	**497**	**359**	**295**	**145**	**46**	**21**	**1,862**
Conifer Evergreen Medium (CEM)										
Juniperus californica	0	0	0	4	0	0	0	0	0	4
Pinus brutia	0	0	0	1	0	0	0	0	0	1
Total	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**5**
Conifer Evergreen Small (CES)										
Juniperus spp.	6	9	11	0	1	0	0	0	0	27
Pinus thunbergiana	0	0	8	5	0	0	0	0	0	13
x Cupressocyparis leylandii	0	0	1	2	0	0	0	0	0	3
Juniperus chinensis	1	1	0	0	0	0	0	0	0	2
Total	**7**	**10**	**20**	**7**	**1**	**0**	**0**	**0**	**0**	**45**
Palm Evergreen Large (PEL)										
Phoenix canariensis	0	1	0	1	13	30	16	2	0	63
Total	**0**	**1**	**0**	**1**	**13**	**30**	**16**	**2**	**0**	**63**

Palm Evergreen Medium (PEM)										
Phoenix dactylifera	0	0	0	103	19	0	0	0	0	122
Phoenix roebelenii	1	11	0	0	0	0	0	0	0	12
Phoenix reclinata	0	0	7	0	0	0	0	0	0	7
Total	**1**	**11**	**7**	**103**	**19**	**0**	**0**	**0**	**0**	**141**
Palm Evergreen Small (PES)										
Washingtonia robusta	3	4	43	728	39	1	0	0	0	818
Arecastrum romanzoffianum	1	6	115	48	3	0	0	0	0	173
Washingtonia filifera	0	0	0	2	1	2	30	0	0	35
Trachycarpus fortunei	2	0	26	0	0	0	0	0	0	28
Chamaerops humilis	0	0	5	0	0	0	0	0	0	5
Archontophoenix cunninghamiana	0	0	4	0	0	0	0	0	0	4
Brahea edulis	0	0	0	3	0	0	0	0	0	3
Xylosma congestum	1	0	0	0	0	0	0	0	0	1
Total	**7**	**10**	**193**	**781**	**43**	**3**	**30**	**0**	**0**	**1,067**
Citywide Total	**4,396**	**4,745**	**7,543**	**7,711**	**4,471**	**2,029**	**884**	**233**	**65**	**32,077**

Table 16 - Replacement Value of Public Trees by Species.

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Cinnamomum camphora	7,285	39,671	1,122,450	8,572,019	17,514,466	13,414,193	9,698,163	4,324,956	943,744	**55,636,948**	34.40
Lagerstroemia indica	664,548	1,331,590	1,189,425	34,700	0	12,671	33,960	0	0	**3,266,893**	2.02
Liquidambar styraciflua	6,411	46,227	713,272	4,188,342	4,673,122	2,242,575	320,697	21,953	0	**12,212,597**	7.55
Magnolia grandiflora	12,753	90,599	1,418,022	4,059,746	2,335,796	946,790	182,579	39,735	0	**9,086,019**	5.62
Pyrus calleryana	199,684	288,994	721,063	390,530	42,778	0	0	0	0	**1,643,049**	1.02
Pistacia chinensis	141,668	252,622	520,136	50,283	0	0	22,344	0	0	**987,053**	0.61
Fraxinus velutina "Modesto"	979	5,711	414,051	1,477,762	1,730,567	796,735	392,986	21,953	0	**4,840,743**	2.99
Cupaniopsis anacardioides	71,182	126,812	631,478	739,878	82,753	10,999	0	0	0	**1,663,102**	1.03
Pinus canariensis	5,442	24,418	335,503	1,637,931	2,004,544	3,026,808	1,130,650	119,204	0	**8,284,499**	5.12
Platanus acerifolia	7,978	31,888	138,586	965,158	2,354,218	2,254,259	1,050,153	497,612	0	**7,299,854**	4.51
Washingtonia robusta	558	878	10,865	214,953	13,094	384	0	0	0	**240,731**	0.15
Quercus agrifolia	15,170	29,913	211,581	785,419	2,404,310	2,855,675	2,255,689	588,489	48,940	**9,195,185**	5.69
Pyrus kawakamii	36,490	124,731	583,385	383,793	0	0	0	0	0	**1,128,400**	0.70
Pinus halepensis	1,423	4,050	135,687	654,480	810,306	1,019,063	1,665,261	1,033,643	449,270	**5,773,182**	3.57
Fraxinus velutina	630	323	82,987	342,254	363,102	258,090	85,119	10,206	0	**1,142,711**	0.71
Brachychiton populneum	2,858	6,494	286,794	690,451	275,574	158,517	0	0	0	**1,420,689**	0.88
Tabebuia impetiginosa	80,057	105,831	410,530	89,451	0	0	0	0	0	**685,869**	0.42
Liriodendron tulipifera	52,873	74,928	230,423	249,429	9,208	0	0	0	0	**616,860**	0.38
Jacaranda mimosifolia	14,587	35,641	257,922	716,987	876,211	173,006	81,638	0	0	**2,155,992**	1.33
Platanus racemosa	1,889	1,330	118,075	522,008	924,912	1,683,557	1,512,559	425,396	46,287	**5,236,013**	3.24
Quercus ilex	2,173	14,201	255,933	992,382	703,852	263,685	120,682	0	0	**2,352,907**	1.45
Chitalpa spp.	36,038	116,945	250,579	0	0	0	0	0	0	**403,562**	0.25
Gleditsia traicanthos	7,842	57,314	363,480	117,044	0	10,621	0	0	0	**556,300**	0.34
Koelreuteria bipinnata	12,233	30,029	252,723	533,362	57,935	0	0	0	0	**886,282**	0.55
Ulmus parvifolia	1,885	12,861	66,574	512,493	1,168,878	154,001	60,459	0	0	**1,977,150**	1.22
Ficus retusa ssp nitida	1,317	5,366	55,615	957,000	1,574,015	565,151	0	0	0	**3,158,463**	1.95
Cassia leptophylla	47,968	77,263	97,698	0	0	0	0	0	0	**222,929**	0.14
Tristaniopsis conferta	21,926	49,274	378,828	213,104	17,278	0	0	0	0	**680,410**	0.42
Podocarpus gracilior	5,262	34,644	338,021	340,571	46,972	0	0	0	0	**765,470**	0.47
Sophora japonica	27,582	66,516	66,304	0	0	0	0	0	0	**160,402**	0.10
Geijera parviflora	11,803	41,140	139,817	162,492	15,657	0	0	0	0	**370,909**	0.23
Prunus cerasifera	70,723	51,798	7,848	0	0	0	0	0	0	**130,370**	0.08
Arecastrum romanzoffianum	181	1,931	43,910	22,277	1,659	0	0	0	0	**69,958**	0.04

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Fraxinus uhdei	2,497	6,123	31,421	137,312	219,302	141,969	96,456	28,014	0	**663,094**	0.41
Ceratonia siliqua	336	0	8,311	61,490	294,294	292,707	332,245	178,413	44,536	**1,212,331**	0.75
Callistemon citrinus	2,790	43,983	287,192	24,204	0	0	0	0	0	**358,169**	0.22
Podocarpus macrophyllus	599	43,491	277,143	51,040	0	0	0	0	0	**372,273**	0.23
Phoenix dactylifera	0	0	0	96,039	16,771	0	0	0	0	**112,810**	0.07
Catalpa speciosa	0	0	18,205	58,692	253,817	264,811	234,214	0	0	**829,740**	0.51
Ligustrum lucidum	1,625	5,349	98,210	95,065	0	0	0	0	0	**200,249**	0.12
Hymenosporum flavum	15,453	32,972	90,919	0	0	0	0	0	0	**139,344**	0.09
Arbutus unedo	32,112	0	7,460	0	12,374	0	0	0	0	**51,946**	0.03
Bauhinia variegata	20,319	24,968	26,251	5,147	0	0	0	0	0	**76,685**	0.05
Eucalyptus citriodora	1,450	4,182	46,219	164,833	72,723	79,770	0	0	0	**369,178**	0.23
Prunus caroliniana	1,450	1,427	34,670	116,360	78,926	68,845	0	0	0	**301,678**	0.19
Brachychiton acerifolium	0	3,874	62,326	128,805	15,708	0	0	0	0	**210,713**	0.13
Agonis flexuosa	4,816	13,133	76,059	16,060	0	18,231	0	0	0	**128,299**	0.08
Eucalyptus sideroxylon	0	3,138	21,529	72,289	112,881	161,752	16,212	0	0	**387,801**	0.24
Cupressus sempervirens	1,289	8,496	52,871	14,806	102,437	76,994	32,423	0	0	**289,316**	0.18
Ulmus americana	314	0	0	20,454	83,414	197,723	445,296	96,961	154,157	**998,320**	0.62
Eucalyptus rudis	0	7,274	9,053	21,516	17,374	6,221	0	0	0	**61,438**	0.04
Eucalyptus camaldulensis	1,429	1,994	23,012	71,288	79,941	59,784	16,212	15,859	18,428	**287,946**	0.18
Phoenix canariensis	0	1,749	0	2,222	32,596	86,752	55,459	8,041	0	**186,820**	0.12
Casuarina equisetifolia	0	0	0	68,143	245,307	144,439	76,647	28,855	0	**563,390**	0.35
Eucalyptus polyanthemos	314	2,037	12,002	84,601	103,130	89,392	38,116	43,907	25,551	**399,049**	0.25
Pinus pinea	552	1,397	21,656	29,095	33,699	51,410	180,060	78,077	249,112	**645,057**	0.40
Morus alba	3,191	6,193	12,760	16,010	5,362	4,924	0	0	0	**48,439**	0.03
Calodendrum capense	8,462	13,912	2,487	26,524	0	0	0	0	0	**51,384**	0.03
Schinus molle	628	11,343	13,373	39,999	0	53,458	15,772	57,445	112,850	**304,869**	0.19
Eucalyptus ficifolia	0	0	9,859	26,524	186,626	156,302	163,276	126,105	83,485	**752,177**	0.47
Pinus radiata	1,710	459	4,398	14,011	51,320	151,498	20,270	28,014	0	**271,679**	0.17
Rhus lancea	0	0	37,085	199,107	71,147	0	0	0	0	**307,339**	0.19
Acer saccharinum	314	2,037	4,608	24,716	43,224	189,404	98,312	31,101	25,551	**419,265**	0.26
Melaleuca quinquenervia	1,317	4,801	51,284	13,698	31,315	147,365	154,155	0	0	**403,934**	0.25
Olea europaea	953	1,257	12,666	64,233	34,949	40,762	0	0	0	**154,819**	0.10
Callistemon viminalis	2,397	7,648	65,696	77,022	21,963	0	0	0	0	**174,726**	0.11
Schinus terebinthifolius	942	2,317	17,419	54,942	66,623	25,667	15,772	0	0	**183,682**	0.11

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Casuarina cunninghamiana	953	0	2,758	33,096	102,035	98,992	0	0	0	**237,834**	0.15
Nerium oleander	11,010	8,009	17,839	13,625	0	0	0	0	0	**50,482**	0.03
Ficus benjamina	1,037	5,224	42,142	0	16,358	0	0	0	0	**64,761**	0.04
Cedrus deodara	250	1,725	11,056	49,512	31,221	41,618	55,965	57,709	0	**249,056**	0.15
Machaerium tipu	942	3,195	43,940	9,659	18,416	15,046	22,344	0	0	**113,543**	0.07
Albizia julibrissin	1,289	5,679	34,841	2,613	6,829	0	0	0	0	**51,251**	0.03
Liquidambar formosana	2,827	10,185	1,349	16,477	52,540	15,046	0	0	0	**98,423**	0.06
Salix spp.	2,199	4,553	35,737	4,829	9,208	0	0	0	0	**56,526**	0.03
Washingtonia filifera	0	0	0	1,041	580	1,286	21,116	0	0	**24,023**	0.01
Eucalyptus globulus	6,295	0	0	9,022	10,188	41,697	29,928	27,616	11,791	**136,538**	0.08
Koelreuteria paniculata	3,492	8,523	12,811	0	9,208	0	0	0	0	**34,035**	0.02
Melia azedarach	222	679	7,305	39,034	65,540	45,138	76,231	21,953	0	**256,102**	0.16
Robinia pseudoacacia	1,928	4,022	6,685	18,589	29,650	16,987	5,848	0	0	**83,708**	0.05
Ilex altaclarensis	1,849	8,154	27,618	6,442	0	0	0	0	0	**44,062**	0.03
Ginkgo biloba	6,220	1,155	9,216	15,687	0	0	0	0	0	**32,279**	0.02
Magnolia x soulangiana	9,071	578	4,242	6,442	0	0	0	0	0	**20,333**	0.01
Betula pendula	5,605	11,689	7,927	1,021	0	0	0	0	0	**26,241**	0.02
Sequoia sempervirens	0	952	24,237	16,802	6,748	18,740	16,282	0	0	**83,763**	0.05
Trachycarpus fortunei	641	0	16,457	0	0	0	0	0	0	**17,098**	0.01
Eriobotrya deflexa	967	3,562	37,343	0	0	0	0	0	0	**41,872**	0.03
Grevillea robusta	0	855	0	0	39,624	90,345	86,136	0	0	**216,960**	0.13
Juniperus spp.	2,108	9,104	37,285	0	12,197	0	0	0	0	**60,693**	0.04
Malus spp.	2,497	7,702	22,381	0	0	0	0	0	0	**32,579**	0.02
Ulmus pumila	638	1,141	3,408	7,691	17,644	24,537	25,733	0	0	**80,792**	0.05
Eucalyptus nicholii	953	1,257	6,656	33,358	30,128	10,999	0	0	0	**83,351**	0.05
Fraxinus americana	942	0	12,474	13,068	82,872	21,596	0	0	0	**130,952**	0.08
Araucaria heterophylla	375	5,915	10,353	4,339	0	0	0	0	0	**20,982**	0.01
Citrus spp.	1,901	8,612	22,211	0	0	0	0	0	0	**32,725**	0.02
Stenocarpus sinuatus	2,625	9,833	4,106	0	0	0	0	0	0	**16,564**	0.01
Juglans regia	314	679	4,608	22,727	6,500	79,125	31,544	62,202	25,551	**233,249**	0.14
Eucalyptus viminalis	222	479	1,349	0	27,624	30,092	107,775	106,109	144,788	**418,438**	0.26
Cercis canadensis	10,086	952	4,765	0	0	0	0	0	0	**15,803**	0.01
Photinia x fraseri	1,054	8,944	18,343	8,945	0	0	0	0	0	**37,287**	0.02
Pittosporum rhombifolium	0	2,135	17,562	9,078	0	0	0	0	0	**28,775**	0.02

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Eriobotrya japonica	5,800	4,773	1,432	0	0	0	0	0	0	**12,005**	0.01
Paulownia tomentosa	314	679	18,543	9,659	18,416	15,046	22,344	31,101	0	**116,101**	0.07
Eucalyptus leucoxylon	0	1,784	11,564	66,299	64,032	0	0	0	0	**143,679**	0.09
Tristaniopsis laurina	623	3,753	27,534	19,189	9,560	0	0	0	0	**60,660**	0.04
Alnus cordata	0	0	5,088	24,283	8,900	0	0	0	0	**38,272**	0.02
Juglans nigra	2,199	975	0	4,829	22,208	10,621	15,772	0	36,197	**92,800**	0.06
Acer negundo	314	679	4,608	6,818	22,208	21,242	38,116	21,953	0	**115,937**	0.07
Acacia species	494	800	20,617	32,120	0	0	0	0	0	**54,032**	0.03
Quercus spp.	0	0	13,019	38,650	24,748	0	0	0	0	**76,416**	0.05
Persea americana	281	1,130	2,079	36,750	46,972	0	0	0	0	**87,211**	0.05
Ficus rubiginosa	0	1,680	11,852	0	8,179	13,477	0	0	0	**35,189**	0.02
Pinus thunbergiana	0	0	25,122	42,095	0	0	0	0	0	**67,217**	0.04
Calocedrus decurrens	222	679	1,910	14,488	15,708	55,759	0	0	0	**88,766**	0.05
Fraxinus pennsylvanica	0	0	1,349	4,829	64,456	30,092	22,344	0	0	**123,070**	0.08
Phoenix roebelenii	389	11,019	0	0	0	0	0	0	0	**11,408**	0.01
Pinus coulteri	125	0	1,615	8,677	22,796	41,618	35,282	0	0	**110,113**	0.07
Platanus occidentalis	314	0	0	0	0	15,046	111,718	155,504	0	**282,582**	0.17
Ailanthus altissima	0	2,516	3,259	8,239	24,916	0	0	0	0	**38,930**	0.02
Prunus armeniaca	454	4,022	3,158	3,265	0	0	0	0	0	**10,898**	0.01
Quercus virginiana	0	2,455	16,676	6,442	0	0	0	0	0	**25,573**	0.02
Rhus spp.	0	1,637	15,213	10,989	0	0	0	0	0	**27,838**	0.02
Pinus spp.	15	0	7,599	17,355	0	0	0	0	0	**24,968**	0.02
Acacia melanoxylon	0	0	4,974	9,094	12,374	43,430	21,297	0	0	**91,169**	0.06
Pittosporum undulatum	445	3,530	0	8,030	0	0	0	0	0	**12,006**	0.01
Alnus rhombifolia	0	0	576	9,840	7,591	0	0	0	0	**18,008**	0.01
Carya illinoinensis	0	0	3,821	19,318	6,500	15,046	0	0	0	**44,685**	0.03
Eucalyptus cladocalyx	0	1,242	4,020	2,593	0	0	0	79,470	0	**87,325**	0.05
Prunus domestica	2,211	0	0	0	0	0	0	0	0	**2,211**	0.00
Quercus lobata	0	0	14,921	6,442	0	0	0	29,672	0	**51,034**	0.03
Syzygium paniculatum	0	2,017	6,323	4,853	0	0	0	0	0	**13,194**	0.01
Juglans hindsii	0	0	0	15,057	6,500	6,549	0	21,953	0	**50,059**	0.03
Phoenix reclinata	0	0	10,220	0	0	0	0	0	0	**10,220**	0.01
Pittosporum tobira	0	2,401	10,049	0	0	0	0	0	0	**12,449**	0.01
Prunus persica	1,334	1,396	0	0	0	0	0	0	0	**2,730**	0.00

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Quercus suber	877	3,273	0	0	0	0	0	0	0	**4,150**	0.00
Acacia baileyana	136	2,165	2,079	0	0	0	0	0	0	**4,380**	0.00
Ficus elastica	648	1,155	0	9,094	0	0	0	0	0	**10,897**	0.01
Magnolia spp.	988	0	0	0	0	0	0	0	0	**988**	0.00
Pittosporum viridiflorum	0	0	7,258	8,945	34,557	0	0	0	0	**50,760**	0.03
Acer palmatum	850	679	0	3,409	0	0	0	0	0	**4,938**	0.00
Chamaerops humilis	0	0	4,737	0	0	0	0	0	0	**4,737**	0.00
Dodonaea viscosa	0	2,953	3,390	0	0	0	0	0	0	**6,342**	0.00
Acer species	314	0	0	6,932	9,208	0	0	0	0	**16,454**	0.01
Archontophoenix cunninghamiana	0	0	1,579	0	0	0	0	0	0	**1,579**	0.00
Chorisia speciosa	476	0	1,617	2,613	0	0	16,212	0	0	**20,917**	0.01
Ficus carica	1,256	0	0	0	0	0	0	0	0	**1,256**	0.00
Juniperus californica	0	0	0	19,318	0	0	0	0	0	**19,318**	0.01
Brahea edulis	0	0	0	6,287	0	0	0	0	0	**6,287**	0.00
Cupressus species	0	0	2,028	3,426	6,417	0	0	0	0	**11,871**	0.01
x Cupressocyparis leylandii	0	0	1,029	2,891	0	0	0	0	0	**3,920**	0.00
Erythrina coralloides	0	0	0	8,611	0	0	0	0	0	**8,611**	0.01
Eucalyptus species	0	0	0	0	0	43,430	0	0	0	**43,430**	0.03
Eucalyptus cinerea	324	356	0	2,804	0	0	0	0	0	**3,484**	0.00
Fraxinus spp.	0	0	5,731	0	0	0	0	0	0	**5,731**	0.00
Prunus species	229	1,396	0	0	0	0	0	0	0	**1,625**	0.00
Acacia decurrens	72	0	2,945	0	0	0	0	0	0	**3,017**	0.00
Araucaria araucana	125	0	1,140	0	0	0	0	0	0	**1,265**	0.00
Broussonetia papyrifera	0	0	0	2,574	3,141	0	0	0	0	**5,715**	0.00
Catalpa spp.	0	679	0	0	6,500	0	0	0	0	**7,179**	0.00
Casimiroa edulis	0	0	2,487	0	8,734	0	0	0	0	**11,221**	0.01
Celtis reticulata	0	0	0	4,547	12,374	0	0	0	0	**16,921**	0.01
Heteromeles arbutifolia	0	0	2,393	8,945	0	0	0	0	0	**11,338**	0.01
Juniperus chinensis	152	621	0	0	0	0	0	0	0	**773**	0.00
Melaleuca linariifolia	0	0	3,390	8,945	0	0	0	0	0	**12,335**	0.01
Quercus rubra	314	0	0	4,829	0	0	0	0	0	**5,144**	0.00
Sequoiadendron giganteum	0	466	0	0	0	0	20,683	0	0	**21,148**	0.01
Acer buergeranum	0	0	2,487	0	0	0	0	0	0	**2,487**	0.00

Species	DBH Class (in)										% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	
Annona cherimola	351	0	0	0	0	0	0	0	0	**351**	0.00
Celtis species	0	0	1,323	0	0	0	0	0	0	**1,323**	0.00
Cercis reniformis	141	0	0	0	0	0	0	0	0	**141**	0.00
Erythrina caffra	0	0	0	0	5,072	0	0	0	0	**5,072**	0.00
Eucalyptus torquata	0	800	0	0	0	0	0	0	0	**800**	0.00
Feijoa sellowiana	200	0	0	0	0	0	0	0	0	**200**	0.00
Leptospermum laevigata	0	0	0	0	0	28,390	0	0	0	**28,390**	0.02
Macadamia tetraphylla	0	565	0	0	0	0	0	0	0	**565**	0.00
Pinus brutia	0	0	0	4,829	0	0	0	0	0	**4,829**	0.00
Pinus torreyana	0	0	2,204	0	0	0	0	0	0	**2,204**	0.00
Populus alba	0	0	0	3,409	0	0	0	0	0	**3,409**	0.00
Punicia granatum	0	0	1,755	0	0	0	0	0	0	**1,755**	0.00
Quercus kelloggii	324	0	0	0	0	0	0	0	0	**324**	0.00
Triadica sebifera	314	0	0	0	0	0	0	0	0	**314**	0.00
Xylosma congestum	207	0	0	0	0	0	0	0	0	**207**	0.00
Zelkova serrata	0	0	1,349	0	0	0	0	0	0	**1,349**	0.00
Citywide Total	**1,782,999**	**3,637,256**	**14,092,765**	**33,398,255**	**43,335,599**	**33,247,947**	**21,386,504**	**8,419,181**	**2,420,239**	**161,720,744**	**100.00**

Table 17 - Relative Performance Index (RPI) for All Public Trees.

Species	Dead or Dying	Poor	Fair	Good	RPI	# of Trees Total	% of Total Population
Cinnamomum camphora	0.02	4.60	55.00	40.38	0.90	4,344	13.54
Lagerstroemia indica	0.57	2.88	23.09	73.45	1.03	3,330	10.38
Liquidambar styraciflua	0.00	1.27	49.96	48.77	0.95	2,364	7.37
Magnolia grandiflora	0.05	4.99	42.60	52.36	0.95	2,143	6.68
Pyrus calleryana	0.40	0.64	12.67	86.29	1.09	1,255	3.91
Pistacia chinensis	0.18	0.18	6.71	92.93	1.12	1,132	3.53
Fraxinus velutina "Modesto"	0.00	7.41	78.96	13.63	0.79	1,093	3.41
Cupaniopsis anacardioides	0.00	3.05	34.57	62.38	0.99	1,050	3.27
Pinus canariensis	0.22	0.22	11.43	88.13	1.10	910	2.84
Platanus hybrida	0.11	2.06	19.34	78.49	1.06	874	2.72
Washingtonia robusta	0.00	0.12	0.49	99.39	1.15	818	2.55
Quercus agrifolia	0.65	1.68	19.82	77.85	1.05	772	2.41
Pyrus kawakamii	0.15	1.36	33.23	65.26	1.01	662	2.06
Pinus halepensis	1.88	1.88	16.32	79.92	1.05	533	1.66
Fraxinus velutina	0.00	4.23	49.90	45.88	0.92	497	1.55
Brachychiton populneum	0.00	1.43	37.07	61.51	1.00	491	1.53
Tabebuia impetiginosa	0.00	1.24	13.66	85.09	1.09	483	1.51
Liriodendron tulipifera	0.21	1.05	15.90	82.85	1.08	478	1.49
Jacaranda mimosifolia	0.22	5.40	45.79	48.60	0.93	463	1.44
Platanus racemosa	0.00	3.61	14.70	81.69	1.06	415	1.29
Quercus ilex	0.00	3.47	34.65	61.88	0.99	404	1.26
Chitalpa spp.	0.27	0.27	7.14	92.31	1.12	364	1.13
Gleditsia traicanthos	0.00	0.55	33.24	66.20	1.02	361	1.13
Koelreuteria bipinnata	0.00	0.00	12.54	87.46	1.10	351	1.09
Ulmus parvifolia	0.00	0.29	32.74	66.96	1.02	339	1.06
Ficus retusa ssp nitida	0.00	0.00	46.71	53.29	0.97	319	0.99
Tristaniopsis conferta	0.00	0.00	14.40	85.60	1.09	257	0.80
Cassia leptophylla	0.00	3.13	17.58	79.30	1.06	256	0.80
Podocarpus gracilior	0.00	0.41	13.82	85.77	1.09	246	0.77
Sophora japonica	0.00	1.33	5.75	92.92	1.12	226	0.70
Geijera parviflora	0.00	0.00	10.61	89.39	1.11	198	0.62
Prunus cerasifera	1.07	2.67	12.30	83.96	1.07	187	0.58
Arecastrum romanzoffianum	0.00	0.00	8.09	91.91	1.12	173	0.54
Fraxinus uhdei	0.00	0.58	25.00	74.42	1.05	172	0.54
Ceratonia siliqua	0.00	4.91	75.46	19.63	0.82	163	0.51
Callistemon citrinus	0.00	0.63	43.04	56.33	0.98	158	0.49
Podocarpus macrophyllus	0.00	0.00	20.14	79.86	1.07	139	0.43
Phoenix dactylifera	0.00	2.46	5.74	91.80	1.11	122	0.38
Catalpa speciosa	0.00	28.81	61.86	9.32	0.69	118	0.37
Ligustrum lucidum	0.00	10.62	27.43	61.95	0.96	113	0.35
Hymenosporum flavum	2.68	1.79	17.86	77.68	1.04	112	0.35
Arbutus unedo	0.96	0.00	0.00	99.04	1.14	104	0.32
Bauhinia variegata	0.00	1.14	9.09	89.77	1.10	88	0.27
Eucalyptus citriodora	0.00	2.38	19.05	78.57	1.06	84	0.26
Prunus caroliniana	1.20	27.71	40.96	30.12	0.77	83	0.26
Brachychiton acerifolium	0.00	12.50	32.50	55.00	0.93	80	0.25

Species	Dead or Dying	Poor	Fair	Good	RPI	# of Trees Total	% of Total Population
Agonis flexuosa	1.28	1.28	10.26	87.18	1.08	78	0.24
Eucalyptus sideroxylon	0.00	8.97	20.51	70.51	1.00	78	0.24
Cupressus sempervirens	0.00	0.00	9.09	90.91	1.11	77	0.24
Ulmus americana	0.00	5.19	88.31	6.49	0.77	77	0.24
Eucalyptus rudis	0.00	36.36	50.00	13.64	0.68	66	0.21
Eucalyptus camaldulensis	1.56	3.13	17.19	78.13	1.04	64	0.20
Phoenix canariensis	0.00	0.00	6.35	93.65	1.12	63	0.20
Casuarina equisetifolia	0.00	0.00	11.29	88.71	1.10	62	0.19
Eucalyptus polyanthemos	0.00	8.20	52.46	39.34	0.88	61	0.19
Pinus pinea	0.00	0.00	17.54	82.46	1.08	57	0.18
Morus alba	0.00	5.88	45.10	49.02	0.93	51	0.16
Calodendrum capense	0.00	0.00	12.00	88.00	1.10	50	0.16
Schinus molle	0.00	8.16	24.49	67.35	0.99	49	0.15
Eucalyptus ficifolia	0.00	4.17	41.67	54.17	0.96	48	0.15
Pinus radiata	2.08	0.00	14.58	83.33	1.07	48	0.15
Rhus lancea	0.00	2.13	65.96	31.91	0.88	47	0.15
Acer saccharinum	0.00	8.70	65.22	26.09	0.83	46	0.14
Melaleuca quinquenervia	0.00	0.00	8.70	91.30	1.11	46	0.14
Olea europaea	0.00	6.67	42.22	51.11	0.94	45	0.14
Callistemon viminalis	0.00	2.27	4.55	93.18	1.11	44	0.14
Schinus terebinthifolius	0.00	2.33	46.51	51.16	0.95	43	0.13
Casuarina cunninghamiana	0.00	0.00	36.59	63.41	1.01	41	0.13
Nerium oleander	0.00	2.44	24.39	73.17	1.04	41	0.13
Ficus benjamina	2.56	0.00	20.51	76.92	1.04	39	0.12
Cedrus deodara	0.00	2.63	18.42	78.95	1.06	38	0.12
Machaerium tipu	0.00	0.00	2.70	97.30	1.14	37	0.12
Albizia julibrissin	0.00	2.78	16.67	80.56	1.06	36	0.11
Liquidambar formosana	0.00	0.00	11.11	88.89	1.11	36	0.11
Salix spp.	0.00	0.00	5.71	94.29	1.13	35	0.11
Washingtonia filifera	0.00	0.00	2.86	97.14	1.14	35	0.11
Eucalyptus globulus	0.00	2.94	2.94	94.12	1.11	34	0.11
Koelreuteria paniculata	0.00	2.94	20.59	76.47	1.05	34	0.11
Melia azedarach	0.00	2.94	55.88	41.18	0.91	34	0.11
Robinia pseudoacacia	0.00	20.59	50.00	29.41	0.80	34	0.11
Ilex altaclarensis	0.00	9.09	36.36	54.55	0.94	33	0.10
Ginkgo biloba	0.00	6.25	43.75	50.00	0.93	32	0.10
Magnolia x soulangiana	0.00	0.00	6.25	93.75	1.12	32	0.10
Betula pendula	0.00	0.00	10.00	90.00	1.11	30	0.09
Sequoia sempervirens	0.00	6.67	23.33	70.00	1.01	30	0.09
Trachycarpus fortunei	3.57	3.57	0.00	92.86	1.08	28	0.09
Eriobotrya deflexa	0.00	3.70	22.22	74.07	1.03	27	0.08
Grevillea robusta	0.00	0.00	37.04	62.96	1.01	27	0.08
Juniperus spp.	0.00	0.00	7.41	92.59	1.12	27	0.08
Malus spp.	0.00	0.00	11.11	88.89	1.11	27	0.08
Ulmus pumila	0.00	25.93	62.96	11.11	0.71	27	0.08
Eucalyptus nicholii	0.00	11.54	26.92	61.54	0.96	26	0.08
Fraxinus americana	4.00	4.00	12.00	80.00	1.03	25	0.08
Araucaria heterophylla	0.00	0.00	12.50	87.50	1.10	24	0.07
Citrus spp.	0.00	4.17	45.83	50.00	0.94	24	0.07

Species	Dead or Dying	Poor	Fair	Good	RPI	# of Trees Total	% of Total Population
Stenocarpus sinuatus	0.00	4.17	4.17	91.67	1.10	24	0.07
Juglans regia	0.00	4.35	47.83	47.83	0.93	23	0.07
Eucalyptus viminalis	0.00	0.00	40.91	59.09	0.99	22	0.07
Cercis canadensis	0.00	5.00	10.00	85.00	1.07	20	0.06
Photinia x fraseri	0.00	5.00	25.00	70.00	1.01	20	0.06
Pittosporum rhombifolium	0.00	30.00	60.00	10.00	0.69	20	0.06
Eriobotrya japonica	0.00	0.00	10.53	89.47	1.11	19	0.06
Paulownia tomentosa	0.00	0.00	5.26	94.74	1.13	19	0.06
Eucalyptus leucoxylon	0.00	0.00	33.33	66.67	1.02	18	0.06
Tristaniopsis laurina	5.56	11.11	11.11	72.22	0.96	18	0.06
Alnus cordata	0.00	11.76	11.76	76.47	1.01	17	0.05
Juglans nigra	0.00	6.25	25.00	68.75	1.00	16	0.05
Acer negundo	0.00	0.00	66.67	33.33	0.89	15	0.05
Acacia species	0.00	0.00	0.00	100.00	1.15	15	0.05
Quercus spp.	13.33	0.00	0.00	86.67	0.99	15	0.05
Persea americana	0.00	14.29	35.71	50.00	0.90	14	0.04
Ficus rubiginosa	0.00	7.69	76.92	15.38	0.79	13	0.04
Pinus thunbergiana	0.00	0.00	23.08	76.92	1.06	13	0.04
Calocedrus decurrens	0.00	0.00	25.00	75.00	1.05	12	0.04
Fraxinus pennsylvanica	0.00	0.00	8.33	91.67	1.12	12	0.04
Phoenix roebelenii	0.00	0.00	8.33	91.67	1.12	12	0.04
Pinus coulteri	0.00	0.00	16.67	83.33	1.08	12	0.04
Platanus occidentalis	0.00	0.00	0.00	100.00	1.15	12	0.04
Ailanthus altissima	0.00	0.00	36.36	63.64	1.01	11	0.03
Prunus armeniaca	0.00	27.27	27.27	45.45	0.83	11	0.03
Quercus virginiana	0.00	0.00	9.09	90.91	1.11	11	0.03
Rhus spp.	9.09	0.00	9.09	81.82	1.01	11	0.03
Pinus spp.	10.00	0.00	10.00	80.00	0.99	10	0.03
Acacia melanoxylon	0.00	11.11	44.44	44.44	0.89	9	0.03
Pittosporum undulatum	0.00	0.00	33.33	66.67	1.02	9	0.03
Alnus rhombifolia	0.00	12.50	62.50	25.00	0.81	8	0.02
Carya illinoinensis	0.00	0.00	12.50	87.50	1.10	8	0.02
Eucalyptus cladocalyx	12.50	12.50	12.50	62.50	0.86	8	0.02
Prunus domestica	0.00	0.00	50.00	50.00	0.96	8	0.02
Quercus lobata	0.00	0.00	12.50	87.50	1.10	8	0.02
Syzygium paniculatum	0.00	0.00	62.50	37.50	0.91	8	0.02
Juglans hindsii	0.00	14.29	71.43	14.29	0.77	7	0.02
Phoenix reclinata	0.00	0.00	0.00	100.00	1.15	7	0.02
Pittosporum tobira	0.00	0.00	28.57	71.43	1.04	7	0.02
Prunus persica	0.00	0.00	57.14	42.86	0.93	7	0.02
Quercus suber	0.00	0.00	14.29	85.71	1.09	7	0.02
Acacia baileyana	16.67	0.00	50.00	33.33	0.77	6	0.02
Ficus elastica	0.00	0.00	66.67	33.33	0.89	6	0.02
Magnolia spp.	0.00	0.00	0.00	100.00	1.15	6	0.02
Pittosporum viridiflorum	0.00	16.67	16.67	66.67	0.96	6	0.02
Acer palmatum	0.00	0.00	40.00	60.00	0.99	5	0.02
Chamaerops humilis	0.00	0.00	0.00	100.00	1.15	5	0.02
Dodonaea viscosa	0.00	0.00	80.00	20.00	0.84	5	0.02
Acer species	0.00	25.00	0.00	75.00	0.96	4	0.01

Species	Dead or Dying	Poor	Fair	Good	RPI	# of Trees Total	% of Total Population
Archontophoenix cunninghamiana	0.00	0.00	0.00	100.00	1.15	4	0.01
Chorisia speciosa	0.00	0.00	25.00	75.00	1.05	4	0.01
Ficus carica	0.00	0.00	0.00	100.00	1.15	4	0.01
Juniperus californica	0.00	0.00	0.00	100.00	1.15	4	0.01
Brahea edulis	0.00	0.00	0.00	100.00	1.15	3	0.01
Cupressus species	0.00	0.00	66.67	33.33	0.89	3	0.01
x Cupressocyparis leylandii	0.00	0.00	0.00	100.00	1.15	3	0.01
Erythrina coralloides	0.00	0.00	66.67	33.33	0.89	3	0.01
Eucalyptus species	0.00	33.33	33.33	33.33	0.77	3	0.01
Eucalyptus cinerea	0.00	66.67	0.00	33.33	0.64	3	0.01
Fraxinus spp.	0.00	0.00	0.00	100.00	1.15	3	0.01
Prunus species	0.00	0.00	66.67	33.33	0.89	3	0.01
Acacia decurrens	0.00	50.00	0.00	50.00	0.77	2	0.01
Araucaria araucana	0.00	0.00	50.00	50.00	0.96	2	0.01
Broussonetia papyrifera	0.00	0.00	50.00	50.00	0.96	2	0.01
Catalpa spp.	0.00	0.00	50.00	50.00	0.96	2	0.01
Casimiroa edulis	0.00	0.00	50.00	50.00	0.96	2	0.01
Celtis reticulata	0.00	0.00	50.00	50.00	0.96	2	0.01
Heteromeles arbutifolia	0.00	0.00	50.00	50.00	0.96	2	0.01
Juniperus chinensis	0.00	0.00	0.00	100.00	1.15	2	0.01
Melaleuca linariifolia	0.00	0.00	0.00	100.00	1.15	2	0.01
Quercus rubra	0.00	0.00	0.00	100.00	1.15	2	0.01
Sequoiadendron giganteum	0.00	0.00	0.00	100.00	1.15	2	0.01
Acer buergeranum	0.00	0.00	0.00	100.00	1.15	1	0.00
Annona cherimola	0.00	0.00	0.00	100.00	1.15	1	0.00
Celtis species	0.00	0.00	0.00	100.00	1.15	1	0.00
Cercis reniformis	0.00	100.00	0.00	0.00	0.38	1	0.00
Erythrina caffra	0.00	0.00	0.00	100.00	1.15	1	0.00
Eucalyptus torquata	0.00	0.00	0.00	100.00	1.15	1	0.00
Feijoa sellowiana	0.00	0.00	0.00	100.00	1.15	1	0.00
Leptospermum laevigata	0.00	0.00	0.00	100.00	1.15	1	0.00
Macadamia tetraphylla	0.00	0.00	100.00	0.00	0.77	1	0.00
Pinus brutia	0.00	0.00	0.00	100.00	1.15	1	0.00
Pinus torreyana	0.00	0.00	0.00	100.00	1.15	1	0.00
Populus alba	0.00	0.00	100.00	0.00	0.77	1	0.00
Punicia granatum	0.00	0.00	100.00	0.00	0.77	1	0.00
Quercus kelloggii	0.00	0.00	0.00	100.00	1.15	1	0.00
Triadica sebifera	0.00	0.00	0.00	100.00	1.15	1	0.00
Xylosma congestum	0.00	0.00	100.00	0.00	0.77	1	0.00
Zelkova serrata	0.00	0.00	100.00	0.00	0.77	1	0.00
Citywide Total	**0.22**	**2.96**	**32.07**	**64.75**	**1.00**	**32,075**	**100.00**

Table 18 – Total Land area and Canopy Coverage.

City of Burbank Total Land Area (Acres)	Total Area Covered by Public Tree Canopy	% of Total Land Covered by Public Tree Canopy	Total Street and Sidewalk Area (Acres)	Total Street and Sidewalk Area Covered by Public Tree Canopy	Canopy Cover as a % of Total Streets and Sidewalks
11,008 Acres (17.2 mi^2)	**370**	**3.4%**	**1673**	**331**	**19.8%**

Appendix C: STRATUM Output Reports by Zone

Table 19 – Population Summary of Public Street Trees.

Species	DBH Class (in)									Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	
Broadleaf Deciduous Large (BDL)										
Fraxinus velutina "Modesto"	4	13	312	416	252	72	22	1	0	**1,092**
*Platanus hybrida**	19	45	43	201	231	124	41	10	0	**714**
Liriodendron tulipifera	179	118	122	48	0	0	0	0	0	**467**
Gleditsia traicanthos	27	95	212	26	0	1	0	0	0	**361**
BDL OTHER	14	20	42	78	112	115	88	11	9	**489**
Total	**243**	**291**	**731**	**769**	**595**	**312**	**151**	**22**	**9**	**3,123**
Broadleaf Deciduous Medium (BDM)										
Liquidambar styraciflua	21	64	401	1,027	591	173	16	1	0	**2,294**
Pistacia chinensis	442	355	215	10	0	0	0	0	0	**1,022**
Koelreuteria bipinnata	63	43	111	90	5	0	0	0	0	**312**
BDM OTHER	107	138	98	55	23	10	6	3	1	**441**
Total	**633**	**600**	**825**	**1,182**	**619**	**183**	**22**	**4**	**1**	**4,069**
Broadleaf Deciduous Small (BDS)										
Lagerstroemia indica	997	1,437	579	7	0	0	3	0	0	**3,023**
Jacaranda mimosifolia	46	36	76	129	79	10	2	0	0	**378**
Chitalpa spp.	113	147	92	0	0	0	0	0	0	**352**
BDS OTHER	179	74	32	12	7	0	0	0	0	**304**
Total	**1,335**	**1,694**	**779**	**148**	**86**	**10**	**5**	**0**	**0**	**4,057**
Broadleaf Evergreen Large (BEL)										
Quercus agrifolia	26	29	32	103	190	145	63	8	1	**597**
Fraxinus velutina	1	1	94	200	127	58	14	1	0	**496**
Quercus ilex	7	24	124	169	57	11	4	0	0	**396**
BEL OTHER	52	94	234	247	234	80	37	12	9	**999**
Total	**86**	**148**	**484**	**719**	**608**	**294**	**118**	**21**	**10**	**2,488**
Broadleaf Evergreen Medium (BEM)										
Cinnamomum camphora	43	53	501	1,325	1,371	613	293	93	18	**4,310**
Magnolia grandiflora	77	153	794	792	226	52	7	0	0	**2,101**
Brachychiton populneum	6	12	203	206	43	15	0	0	0	**485**
Ficus retusa ssp nitida	8	7	23	138	117	26	0	0	0	**319**
BEM OTHER	39	64	134	79	62	43	34	11	6	**472**
Total	**173**	**289**	**1,655**	**2,540**	**1,819**	**749**	**334**	**104**	**24**	**7,687**
Broadleaf Evergreen Small (BES)										
Pyrus calleryana	428	359	374	89	5	0	0	0	0	**1,255**
Cupaniopsis anacardioides	159	193	440	212	13	1	0	0	0	**1,018**
Pyrus kawakamii	75	157	300	77	0	0	0	0	0	**609**
Tabebuia impetiginosa	226	103	78	9	0	0	0	0	0	**416**
BES OTHER	509	345	460	150	32	14	0	0	0	**1,510**
Total	**1,397**	**1,157**	**1,652**	**537**	**50**	**15**	**0**	**0**	**0**	**4,808**
Conifer Evergreen Large (CEL)										
Pinus canariensis	32	30	115	232	128	106	30	2	0	**675**
CEL OTHER	11	32	63	61	103	63	82	36	21	**472**
Total	**43**	**62**	**178**	**293**	**231**	**169**	**112**	**38**	**21**	**1,147**
Conifer Evergreen Medium (CEM)										
CEM OTHER	0	0	0	1	0	0	0	0	0	**1**
Total	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Conifer Evergreen Small (CES)										
CES OTHER	3	5	20	7	1	0	0	0	0	**36**
Total	**3**	**5**	**20**	**7**	**1**	**0**	**0**	**0**	**0**	**36**

Palm Evergreen Large (PEL)										
PEL OTHER	0	1	0	1	13	25	16	1	0	**57**
Total	**0**	**1**	**0**	**1**	**13**	**25**	**16**	**1**	**0**	**57**
Palm Evergreen Medium (PEM)										
PEM OTHER	1	0	0	46	9	0	0	0	0	**56**
Total	**1**	**0**	**0**	**46**	**9**	**0**	**0**	**0**	**0**	**56**
Palm Evergreen Small (PES)										
Washingtonia robusta	3	4	28	681	32	1	0	0	0	**749**
PES OTHER	4	6	86	14	0	2	30	0	0	**142**
Total	**7**	**10**	**114**	**695**	**32**	**3**	**30**	**0**	**0**	**891**
Zone Street Total	**3,921**	**4,257**	**6,438**	**6,938**	**4,063**	**1,760**	**788**	**190**	**65**	**28,420**

Table 20 – Population summary of Park Trees.

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total
Broadleaf Deciduous Large (BDL)										
Platanus racemosa	10	3	53	83	58	52	22	7	0	**288**
*Platanus hybrida**	9	4	37	24	42	32	6	6	0	**160**
BDL OTHER	16	1	17	16	12	3	5	5	0	**75**
Total	**35**	**8**	**107**	**123**	**112**	**87**	**33**	**18**	**0**	**523**
Broadleaf Deciduous Medium (BDM)										
Pistacia chinensis	19	25	64	1	0	0	1	0	0	**110**
Liquidambar styraciflua	0	12	33	12	12	1	1	0	0	**71**
Koelreuteria bipinnata	19	8	11	1	0	0	0	0	0	**39**
BDM OTHER	46	31	45	20	13	4	2	1	0	**162**
Total	**84**	**76**	**153**	**34**	**25**	**5**	**4**	**1**	**0**	**382**
Broadleaf Deciduous Small (BDS)										
Lagerstroemia indica	117	111	77	1	0	1	0	0	0	**307**
Jacaranda mimosifolia	4	14	44	17	5	0	1	0	0	**85**
Bauhinia variegate	26	30	20	0	0	0	0	0	0	**76**
BDS OTHER	25	31	60	4	0	1	1	0	0	**122**
Total	**172**	**186**	**201**	**22**	**5**	**2**	**2**	**0**	**0**	**590**
Broadleaf Evergreen Large (BEL)										
Quercus agrifolia	22	9	56	33	30	4	15	6	0	**175**
Eucalyptus sideroxylon	0	6	16	17	11	10	1	0	0	**61**
Ulmus parvifolia	0	2	4	28	26	1	0	0	0	**61**
Eucalyptus camaldulensis	3	0	11	17	12	5	1	0	0	**49**
BEL OTHER	14	17	39	61	18	15	5	6	0	**175**
Total	**39**	**34**	**126**	**156**	**97**	**35**	**22**	**12**	**0**	**521**
Broadleaf Evergreen Medium (BEM)										
Calodendrum capense	26	17	1	0	0	0	0	0	0	**44**
Magnolia grandiflora	11	19	4	5	0	2	0	1	0	**42**
BEM OTHER	9	14	53	35	14	6	1	2	0	**134**
Total	**46**	**50**	**58**	**40**	**14**	**8**	**1**	**3**	**0**	**220**

Broadleaf Evergreen Small (BES)										
Tabebuia impetiginosa	10	7	49	1	0	0	0	0	0	**67**
Tristaniopsis conferta	1	16	44	1	0	0	0	0	0	**62**
Pyrus kawakamii	4	12	27	10	0	0	0	0	0	**53**
Geijera parviflora	22	24	2	0	0	0	0	0	0	**48**
Callistemon viminalis	12	4	16	8	1	0	0	0	0	**41**
BES OTHER	23	27	71	27	5	1	1	0	0	**155**
Total	**72**	**90**	**209**	**47**	**6**	**1**	**1**	**0**	**0**	**426**
Conifer Evergreen Large (CEL)										
Pinus halepensis	5	7	78	128	64	46	13	3	0	**344**
Pinus canariensis	5	14	46	55	50	54	10	1	0	**235**
Pinus radiate	4	0	2	4	10	18	2	1	0	**41**
CEL OTHER	9	7	39	17	4	8	8	3	0	**95**
Total	**23**	**28**	**165**	**204**	**128**	**126**	**33**	**8**	**0**	**715**
Conifer Evergreen Medium (CEM)										
CEM OTHER	0	0	0	4	0	0	0	0	0	**4**
Total	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**4**
Conifer Evergreen Small (CES)										
CES OTHER	4	5	0	0	0	0	0	0	0	**9**
Total	**4**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**
Palm Evergreen Large (PEL)										
PEL OTHER	0	0	0	0	0	5	0	1	0	**6**
Total	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**1**	**0**	**6**
Palm Evergreen Medium (PEM)										
Phoenix dactylifera	0	0	0	57	10	0	0	0	0	**67**
PEM OTHER	0	11	7	0	0	0	0	0	0	**18**
Total	**0**	**11**	**7**	**57**	**10**	**0**	**0**	**0**	**0**	**85**
Palm Evergreen Small (PES)										
Arecastrum romanzoffianum	0	0	59	37	3	0	0	0	0	**99**
Washingtonia robusta	0	0	15	47	7	0	0	0	0	**69**
PES OTHER	0	0	5	2	1	0	0	0	0	**8**
Total	**0**	**0**	**79**	**86**	**11**	**0**	**0**	**0**	**0**	**176**
Zone Park Total	**475**	**488**	**1,105**	**773**	**408**	**269**	**96**	**43**	**0**	**3,657**

Table 21 – Overhead Utility Line Conflicts for Public Trees by Zone.

Zone Segment	No Lines	%	Present and not conflicting	%	Present and conflicting	%	Total Number of Trees in conflict or with potential for future conflict
Park	3,231	88.4%	388	10.6%	**38**	1.0%	426
Street	*Insufficient Data*						
Park Total	**3,231**		**388**		**38**		**426**

Table 22 – Public Tree Sidewalk Conflicts by Zone.

Zone Segment	0 - 3/4 inch		3/4 - 1 1/2 inches		> 1 1/2 inches		Total Number of Conflict
Park	3,636	99.4%	16	0.4%	5	0.1%	**3,657**
Street	*No Data Available*						
Park Total	**3,636**		**16**		**5**		**3,657**

Table 23 – Hardscape Canopy Coverage by Zone.

Zone	Acres	% of Total Public Tree Canopy
Park	39.01	10.53
Street	331.40	89.47
Citywide Total	**370.41**	**100.00**

Table 24 – Replacement Value of Public Trees by Zone.

Zone	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42	Total	% of Total
Park	179,559	384,834	2,182,105	3,228,219	3,741,012	4,013,973	2,295,778	1,343,356	0	**17,368,836**	10.74
Street	1,603,440	3,252,422	11,910,660	30,170,036	39,594,588	29,233,974	19,090,727	7,075,825	2,420,239	**144,351,907**	89.26
Citywide Total	**1,782,999**	**3,637,256**	**14,092,765**	**33,398,255**	**43,335,599**	**33,247,948**	**21,386,504**	**8,419,181**	**2,420,239**	**161,720,743**	**100.00**

Table 25 – Annual CO2 Benefits of Public Trees by Zone.

Zone	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Net Total (lb)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Park	375,335.84	5,630.04	- 59,956.10	- 713.12	- 910.04	314,666.63	**4,720.00**	11.40	12.44	**1.29**
Street	2,762,016.75	41,430.25	- 541,688.13	- 5,541.95	- 8,208.45	2,214,786.75	**33,221.80**	88.60	87.56	**1.17**
Citywide Ttotal	**3,137,352.50**	**47,060.29**	**- 601,644.25**	**- 6,255.07**	**- 9,118.49**	**2,529,453.25**	**37,941.80**	**100.00**	**100.00**	**1.18**

Table 26 – Annual Air Quality Benefits of Public Trees by Zone.

Species	Deposition O_3 (lb)	Deposition NO_2 (lb)	Deposition PM_{10} (lb)	Deposition SO_2 (lb)	Total Deposition ($)	Avoided NO_2 (lb)	Avoided PM_{10} (lb)	Avoided VOC (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% of Total Tree No.	Avg. $/tree
Park	1,547.92	708.83	887.49	55.78	83,844.50	5.86	62.88	27.85	3,417.02	- 1,991.20	- 6,650.62	1,305.44	80,610.91	11.40	22.04
Street	11,901.75	4,969.16	6,563.72	445.36	623,769.81	69.36	513.64	227.93	28,270.12	- 13,496.89	- 45,079.63	11,194.42	606,960.31	88.60	21.36
Citywide Total	**13,449.67**	**5,677.99**	**7,451.21**	**501.14**	**707,614.31**	**75.22**	**576.52**	**255.78**	**31,687.14**	**- 15,488.10**	**- 51,730.25**	**12,499.86**	**687,571.31**	**100.00**	**21.44**

Appendix D: References

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Appendix E: Additional Resources

Information provided in this report is the result of a STRATUM (Street Tree Resource Analysis Tool for Urban Forest Managers) analysis of Burbank's public tree resource. Data used for this analysis were obtained from the City of Burbank's street tree inventory. STRATUM generates a variety of reports detailing annual benefits, management costs, replacement value, and structural analyses. Inventory data can be obtained from the Burbank TreeKeeper® management system. STRATUM is a computer-based tool found within the i-Tree software suite (i-Tree Cooperative 2006). Additional information concerning i-Tree can be found at http://www.itreetools.com.

This report is based on the entire series of *Municipal Forest Resource Analysis* reports prepared and published by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. These reports are companions to the regional *Tree Guides* and i-Tree's STRATUM application developed by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research and can be found at http://www.fs.fed.us/psw/programs/cufr/