Hurricane Ike
Street Tree Survey
Report and Recommendations

Prepared for

City of Galveston, TX

May 2009

TEXAS FOREST SERVICE
The Texas A&M University System

Galveston Street Tree Survey—Addendum #1

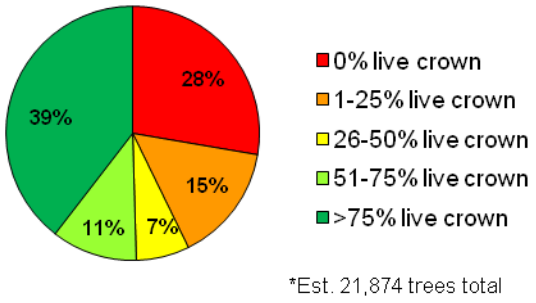
Following publication of the *Hurricane Ike Street Tree Survey Report & Recommendations* for Galveston, Texas, the authors conducted additional analysis of the data recorded during the survey of April 21-22, 2009.

Crown Classes

As described in the full report, different species reacted differently to the salty storm surge of Hurricane Ike (**page 5**). In particular, the various species of palms showed only modest impact, with only 8.3% of these trees tallied showing less than 50% canopy cover. Most other tree species showed much higher rates of canopy loss (**Appendix B**).

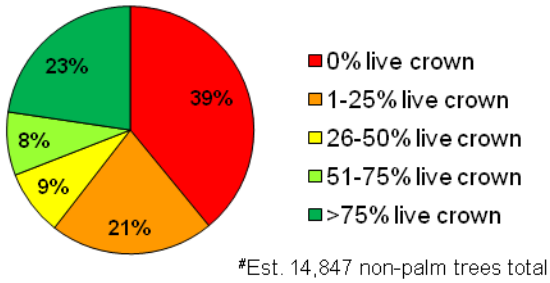
Figures 3a and 3b below show the percent of trees surveyed, by crown class, first including palm trees and then excluding palms. This gives a rough indication of how many right-of-way (ROW) trees may be dead (0% live crown), dying (1-25% live crown), doubtful (26-50% live crown), may recover (51-75% live crown), or are recovering (>75% live crown).

Figure 3a: Estimated % of Trees by Crown Class (all tree species*)



*Est. 21,874 trees total

Figure 3b: Estimated % of Trees by Crown Class (excluding palms#)



#Est. 14,847 non-palm trees total

Key findings:

Out of all the trees surveyed, roughly one-half have less than 50% live crown cover and 28% of trees show no signs of life. When palms are excluded (since most palms appear to be recovering), the data is even more striking: an estimated 5,797 of these non-palm trees (39% of the 14,847 total) show no signs of life and 69% have less than 50% crown cover.

One positive note is that 23% of trees other than palms have good leaf canopy and appear to be recovering from the storm surge. However, summer heat or other climatic conditions like drought could have an impact on these categories. Trees near 50% live crown today could still succumb to additional stresses by the end of the summer.

Contents

Credits

The Texas Community Tree Inventory (TXCTI) system and report was developed by the Texas Forest Service. It is adapted from the Street Tree Management Tool for Urban Forest Managers (STRATUM) computer model developed by researchers at the Center for Urban Forest Research, a research unit of the USDA Forest Service's Pacific Southwest Research Station. Any statistical equations used to compute Standard Error values and percentages were specifically drawn from the STRATUM model, as published in the user's manual. For more information about STRATUM or the other i-Tree tools, go to www.itreetools.org.

Recommendations provided are the judgment of the Texas Forest Service foresters listed below, based on the data collected in cooperation with community staff or volunteers.

Report prepared by:

Pete Smith, CF, CA
College Station, TX

Mickey Merritt, CF
Houston, TX

Executive Summary

On April 21-22, 2009, Texas Forest Service foresters, in cooperation with the Galveston County AgriLife Extension Service and a team of Galveston County Master Gardener volunteers, conducted a sample street tree survey in Galveston, Texas, covering 9.47 miles, or roughly 5 percent of the 204 miles of streets in the study area.

Results include:

* An estimated **10,840** right-of-way (ROW) trees have less than 50% canopy cover, meaning they are dead or likely to die.
* FEMA removal costs for eligible ROW trees are estimated to be **$706,180**.
* In addition, an estimated **31,000** private trees are also dead and will become debris.
* Palms (all species) tolerated the saltwater storm surge better than most other tree species; American sycamore showed low tolerance, with 100% mortality.
* Dead and dying ROW trees had a pre-storm landscape value totaling **$48.6 million**.
* There are an estimated **27,500** potential tree planting sites along city streets.
* Replanting the **10,840** dead or dying ROW trees could cost **$2.2 million**.

Recommendations include:

* Develop a plan for determining which trees will be removed, when, and by whom.
* Hire a qualified urban forester to serve the city's interests in tree issues.
* Plan and conduct the necessary repairs and improvements to streets before planting new trees.
* Write a detailed community reforestation plan to guide replanting efforts.
* Engage the community in fundraising and establish partnerships to execute the plan through an official city tree board, sanctioned by an ordinance passed by city council.

Reason for Survey

In September 2008, Hurricane Ike slammed into Galveston with 110-mph winds and a 15-foot storm surge, inundating most of the city. In addition to flooded homes and businesses, many of the city's historic trees were also damaged or destroyed. City leaders quickly recognized that wholesale removal of right-of-way (ROW) trees following the storm would forever alter the historic landscape of Galveston and pose a barrier to long-term recovery. At the request of the Galveston Planning & Community Development Department's historic preservation officer, two Texas Forest Service (TFS) urban foresters went to Galveston to begin damage assessments of trees in the historic districts and along Broadway Boulevard.

The goal of this initial assessment was to avoid the unintentional and unnecessary removal of public trees during debris clearing activities within four historic districts. The process included a brief, visual inspection of storm-damaged trees that posed an immediate risk to the public or adjacent property due to uprooting, excessive lean, crown loss (in excess of 50%), or trunk fractures (standards from the FEMA 325 *Debris Management Guide*). Each tree that met the standard for removal was marked and photographed. TFS foresters completed tree assessments in the National Landmark, Cedar Lawn, Lost Bayou and Silk Stocking historic districts on Sept. 18, 2008, and provided a detailed list of destroyed trees to the city. A detailed follow-up assessment of the trees in the center medians of Broadway Boulevard (SH 87) was conducted, with recommendations for mitigating the damaged trees reported in the ***"Tree Mitigation Plan for Broadway Boulevard"*** sent to city leaders last October *[and excerpted above]*.

While performing these early assessments it was apparent that almost all trees in Galveston were suffering from excessive salt exposure – either from wind-borne salt spray, the storm surge or both. Within two weeks, most trees and plants showed brown leaves that were quickly shed. Very few tree species were spared, the most notable exceptions being the various species of palm.

Visits to the Island in March 2009 showed that little had changed following the start of spring green-up: most of Galveston's trees still had few or no leaves. With the deadline for FEMA debris removal looming at the end of April, city staff and TFS urban foresters decided to conduct a random sample of streets to determine the extent of potential losses from salt poisoning, both to city ROW trees and to trees on private property. This report details the results of that survey.

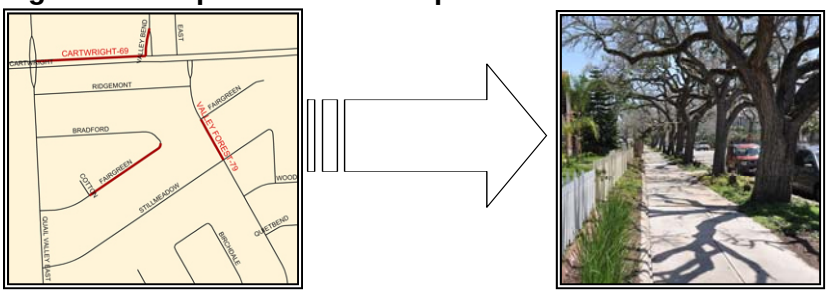
Survey Goals

1) Quickly estimate how many trees along the public right-of-way in Galveston have more than 50% crown loss, the FEMA cost of removing eligible trees, and the loss in value to the city.
2) Quickly estimate the number of dead or dying trees on private property.
3) Determine if there were measureable differences in salt tolerance among tree species.
4) Estimate the number of potential planting sites along Galveston's streets.

Methods

The survey in Galveston was modeled after the **Texas Community Tree Inventory** (TXCTI) system, a more generic system used to sample street trees in Texas cities. Typically, Texas Forest Service (TFS) foresters identify and survey a 5-15% random sample of street segments, or "blocksides" (see **Figure 1** below), and collect data on the individual trees they find there.

Figure 1: Sample Blockside Map



Sidewalk view

On April 21-22, 2009, TFS foresters, in cooperation with the Galveston County AgriLife Extension Service and a team of Galveston County Master Gardener volunteers, conducted a modified TXSCTI survey in Galveston, Texas. The study area was bounded by Seawall Boulevard, Ferry Road, Harborside Boulevard, and 83rd Street. Teams surveyed a total of 165 segments totaling almost 9.5 miles within the 204-mile study area. **Table 1** summarizes the basic parameters of this survey.

Table 1: Street Tree Survey Statistics

Total Miles (# blocksides):	204.17	(3,358)
Miles Sampled (# blocksides):	9.47	(165)
Sample size (% of blocksides):	4.64%	(4.9%)
Multiplier:	21.55	
Standard Error:	8.5%	

Field data collection was limited to very few measurements in order to speed up the process for the volunteers (see **Appendix A** for data collection form and instructions). Teams walked both sides of each assigned street segment and recorded the following data for all trees over 1" diameter (at 4.5 feet above ground) within the street ROW:

- species
- diameter-at-breast-height (DBH) in six possible classes
- percent live canopy remaining, in five possible classes

For each street segment, volunteers also counted the total number of trees on private property (within adjacent lots) that appeared to be dead or dying, as well as the total number of potential planting sites within the ROW.

Assuming that the randomly selected segments are representative of the streets in Galveston, volunteers evaluated 4.64% of all the street miles in the study area. This means that each tallied tree represents 21.55 trees over the entire street tree population in the study area. This “multiplier” is then used to estimate the number of ROW trees in the different report categories, such as species, diameter class or crown class. It also is used to estimate the number of dead or dying private trees and the number of available planting sites in the ROW. The sample is considered statistically valid if the calculated “standard error” for the total number of trees is less than 20%. In Galveston, we calculated the standard error to be 8.5%.

Survey Results

Initial results generated from this sample survey were sent via email to city staff on April 24, 2009. This basic report included the estimated total number of ROW trees in each diameter class, how many appear to be dead or dying from salt poisoning, and the estimated cost (using FEMA removal rates) of removing all the trees with less than 50% canopy cover. These trees will begin to decay soon, have lost all their value, and qualify for removal under FEMA's debris standards. Table 2 shows these results, as reported previously.

Table 2: Estimated Number of ROW Trees, Mortality, and Potential Removal Costs

DBH Class	DBH Range	Total No. Trees Tallied	*Estimated Total No. ROW Trees	Estimated No. Trees w/<50% Canopy	% Trees w/<50% Canopy	FEMA Removal Rates	Estimated FEMA Removal Cost	Standard Error (+/-) 8.5%
1	1-6''	284	6,120	3,254	53.2%	$0	$0	$0
2	7-12''	288	6,207	3,556	57.3%	$40	$142,240	$12,090
3	13-24''	293	6,314	3,060	48.5%	$120	$367,200	$31,212
4	25-36''	135	2,909	862	29.6%	$195	$168,090	$14,288
5	37-48''	14	302	86	28.5%	$250	$21,500	$1,828
6	49''+	1	22	22	100.0%	$325	$7,150	$608
Totals:		**1,015**	**21,874**	**10,840**			**$706,180**	**$60,025**
***Private trees:**		**1,444**		**31,119**				

*using multiplier of 21.55

Key findings:

An estimated **10,840** public ROW trees (+/- 921) currently have less than 50% canopy cover, meaning they are dead or likely to die and many will become potentially hazardous to the public over the next few months. Removal costs for eligible trees over 6'' in diameter are estimated to be **$706,180** (+/- $60,025) after applying FEMA removal rates provided by the City of Galveston. This estimate does not include the costs of marking individual trees destined for removal or the costs of monitoring the removal contract.

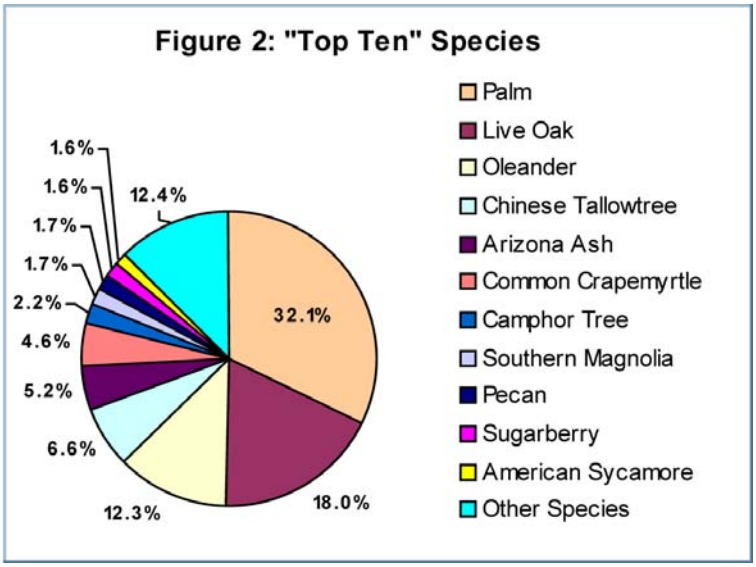
In addition, debris removal costs for 3,254 small trees (1-6'' in diameter) and an estimated 31,000 private trees will need to be added to this estimate since the city may ultimately be responsible for disposing of this debris. And since not all the trees with canopy over 50% will ultimately survive, those removal and disposal costs would be in addition to the estimates provided here.

In particular, the number and size of trees on private property is still largely unknown. Our survey teams did not go onto private property and did not measure diameters for any private trees. The estimate provided is useful only to get a sense of the scale of the debris problem that these owners – and the City of Galveston – face.

Species

The diversity of species within the population of street trees in a city is of primary concern to municipal urban foresters and arborists charged with managing this resource. As a rule, we recommend having no more than 10% of trees made up of any single species, which can prevent the catastrophic loss of trees due to an outbreak of insects or disease. Species diversity is one sign of a healthy tree resource.

Figure 2 shows the most common species found in the sample survey. The top eleven species are shown (two tied for tenth place), plus a category combining the remaining species. A complete list of species encountered during the inventory is listed in **Appendix B**.



Key findings:

Because Galveston is situated on a barrier island, the kinds of trees planted over the years generally reflect those that survive and grow in a maritime environment. In particular, salt spray from the Gulf of Mexico and Galveston Bay regularly impact trees and can limit their growth. So it is no surprise to find that the various species of palm trees (all grouped together for the purposes of this survey) and live oak (*Quercus virginiana*) make up 50% of street trees. In fact, the top eleven species recorded account for over 87% of the street trees in the city. **Appendix B** shows the entire list of ROW species identified.

The primary reason for identifying species in this survey, though, was to try to see which ones – if any – might have resisted the poisoning effects of the salty storm surge brought on by Hurricane Ike. The last two columns of **Appendix B** show the number of trees tallied for each species that possess less than 50% crown canopy and the percentage affected. Of the most common trees, only palm species (8.3% mortality) and oleanders (*Nerium oleander*) (39.2%) showed much tolerance to saltwater inundation. An exotic species, Norfolk-Island-Pine (*Araucaria heterophylla*) was the only species observed that seemed completely unfazed by the saltwater. Live oak was a relative success story with only 61.7% of trees found dead or dying.

In contrast, American sycamore (*Platanus occidentalis*) (100% mortality) and Chinese tallowtree (*Triadica sebifera*) (97%) showed very low resistance to this flooding. In fact, there was little question about mortality among the sycamores, because many were already losing bark and beginning to decay. For the species where only small numbers (5 or fewer) were tallied during the survey, it's difficult to make useful judgments about salt tolerance.

One consideration in developing a plan to reforest Galveston would be to weigh any evaluation of salt tolerance shown here against two other very important factors: resistance to wind damage and mature size. While live oak, Southern magnolia (*Magnolia grandiflora*), and pecan (*Carya illinoinensis*) may appear to be vulnerable to salty storm surge, they didn't fare any worse than other species and they prove to be some of the best in withstanding hurricane-force winds. They also live long and provide extensive shade over streets and yards in Galveston. One other species that would be a logical addition as a street tree – but rarely encountered in our survey – would be baldcypress (*Taxodium distichum*), since it is also very wind-tolerant.

Tree Values

Public trees deliver valuable benefits to a community, and in recent years many of these values have been quantified. These include environmental values such as reducing air and water pollution, storm water reduction, energy savings, and carbon sequestration. Other societal benefits of trees such as quicker hospital recovery time or the aesthetic beauty of street trees are often harder to quantify – but just as important if you ask most citizens.

In Galveston, the benefits trees provide are no different. But one goal of this study is to estimate the loss in tree value to the city for the ROW trees that likely will be removed due to salt poisoning. We do not attempt to calculate the loss in environmental services, but merely the *landscape value* of the city's dead and dying street trees.

Landscape Value

One accepted method for quantifying the landscape value of trees was developed by the Council of Tree and Landscape Appraisers, published as the *Guide for Plant Appraisal–9th Edition (ISA 2000)*. This trunk-formula method combines tree ratings in four categories (species, condition, size, location) and the regional replacement cost/square-inch (from the *2003 Texas Supplement and Species Approximation*) to calculate the cost of replacing a tree specimen in the event it is destroyed.

This sample survey makes three key assumptions:

- all trees with less than 50% canopy are dead or dying and are a total loss;
- all ROW tree locations are equal (a 70% 'location' rating);
- all ROW trees prior to the storm were in 'fair' condition (a 60% 'condition' rating).

These last two assumed values are conservative and serve to moderate the overall calculated landscape value. Only dead or dying trees are included in the loss figures, even though surviving trees may have seen their values reduced significantly.

We then use the average diameter for each of the recorded DBH classes and published species ratings (from the *2003 Texas Supplement and Species Approximation*) to arrive at the estimated replacement value shown in **Table 3**. A complete list of replacement values for destroyed trees by species is shown in **Appendix C**.

Table 3: Loss in Tree Value

Est. Number of Trees:	10,844*
Total Loss:	$48,623,878
Average Tree Value:	$4,485 ea.

*from Appendix C, includes slight rounding error

Key findings:

Dead and dying trees killed by Hurricane Ike's storm surge had a pre-storm landscape value totaling approximately **$48.6 million**, an average of $4,485 each. This loss does not represent the actual cost of planting new trees, but is more like a depreciated insurance loss – even though the city has no such policy on which to collect.

One important factor in this loss estimate is the rather large average diameters of the street trees in Galveston. For many of the most common species, the size of the trees in our survey generate large replacement values, even after depreciating each tree using low location and condition ratings. **Appendix C** highlights the lost value of large trees such as live oak, which has an average diameter of over 19 inches and an average per-tree loss of over $10,000 each.

Replanting

The catastrophic loss of trees in Galveston is both tragic and costly. These include the very real costs to the city and to private citizens for removing dead trees and stumps, debris hauling, infrastructure repairs, and remediation or safety pruning for surviving trees. But the city will not be made "whole" until efforts are made – both public and private – to replant the tens of thousands of trees that have been lost to Hurricane Ike.

Planting Sites

This survey included an assessment of possible planting sites within each street ROW segment. Crews evaluated the area between the curb or edge of street and the ROW boundary adjoining private property, counting the total number of planting sites available for a large- or medium-statured tree (i.e. live oak, pecan, etc.) and avoiding existing trees with more than 50% canopy. If overhead power lines were present, planting sites were separately counted for small-statured species (i.e. crapemyrtle). **Table 4** shows the estimated number of possible planting sites, as well as planting site criteria.

Table 4: ROW Planting Sites

Total Street Miles:	204.17
Street Miles Without Existing Trees:	36.50
% "Unstocked":	17.8%
Estimated No. Large/Medium Tree Planting Sites:	18,274
Estimated No. Small Tree Planting Sites:	9,310
Total Planting Opportunities:	27,584

Planting Site Criteria

Distances: Minimum 4' wide tree lawn
Only small tree under power lines
Street corner, traffic signal - 25'
Hydrant, utility pole, streetlight - 10'
Driveway - 5'
Other medium/large trees - 30-40'

Key findings:

Our sample survey estimates that there are over 18,200 sites within the ROW to plant a large or medium-sized tree and an additional 9,300 sites for small-statured trees for a total of over **27,500** potential tree planting sites in Galveston. These estimates include the 10,840 likely tree removals already described earlier.

The cost of replanting any (or all) of these sites also can be estimated. The cost of a healthy, 15-gallon container-grown tree (such as a live oak) delivered, planted and maintained for two years will likely cost around $200 (*City of Houston cost figure, assuming maintenance by city crews*) or more. This size tree is often recommended for public plantings since it can adapt to the site quickly but is large enough to withstand the pressures of an urban setting. Using this price as a baseline for estimation, replanting just the **10,840** dead or dying trees along Galveston's streets could cost **$2.2 million**.

Recommendations

The purpose of this technical report is to provide city leaders with the results of our sample street tree survey in Galveston and a few brief recommendations for moving forward towards a green, shady community.

Tree Removals: lower the risk to the public from dead & dying trees

The first priority should be to develop a plan for determining exactly which trees will be removed, when and by whom. A key factor in answering any of these questions is whether FEMA grants the city's request for an extension for debris removal. Once that hurdle is cleared, FEMA or the U.S. Army Corps of Engineers may also be tasked with developing and managing the contract for such removals. If not, the city should be prepared to perform this contract oversight.

The city needs a qualified representative to serve its interests when decisions are made about which trees are removed. This will be a difficult process for citizens and opposition to removing trees – no matter how dead – should be expected. Texas Forest Service is prepared to support the city with technical advice and grant funding for a new staff member or a contract urban forester to provide the necessary on-site review. It is in the long-term interests of the city to maintain its own expertise on all tree matters in Galveston.

Tree removal is just the first step. Consideration and planning over the next few months should be devoted to the necessary infrastructure repairs (or improvements) that may be necessary before replanting can begin. This includes stump removals, grading, drainage improvements, sidewalk repairs and soil installation. Some sites have the added complication of historical considerations (curbs, etc.) that may require detailed planning before work begins.

All tree work should conform to the latest ANSI A-300 (Standard Practices for Tree, Shrub and Woody Plant Maintenance), ANSI Z-133 (Safety Standards), and the latest Tree Pruning Guidelines from the International Society of Arboriculture (ISA) or Tree Care Industry Association (TCIA), and should be directed by ISA Certified Arborists.

Replanting: develop a reforestation plan

The cost estimate for replanting the 10,000 or more trees that are likely to be removed is approximately $2 million. This is a significant sum, but is likely to be spread out over several years, perhaps as long as a decade. The community should begin planning for this work.

There are many questions that will need to be answered when it comes time to plant new trees. What size will we choose? What species? What spacing between trees? Where can we begin? Who will do the work – contractor or volunteers? What input will adjacent landowners have? Technical questions can sometimes be answered by the city's new urban forester (or consultant), but many of these answers are actually policy decisions that are best decided by an official city committee, sanctioned by an ordinance passed by city council. One way to create such a tree board might be to make permanent the recently-formed **Galveston Community Recovery Plan (GCRP) Tree Committee**. This group might also help to coordinate fundraising and address concerns about tree removals.

Some cost savings may be generated from partnerships with local foundations, where donated trees may supplement projects designed by city staff. Volunteer labor for planting trees can engage citizens and make them part of the solution. However, proper watering and maintenance must be accounted for as part of this budget in order to be successful.

Appendix A–Part 1: Sample Blockside Data Sheet

Blockside #: _____ **Date:_____** **Crew: _____**

Street: _____ From: _____ To: _____

Tree #	Species Code	DBH Class						Crown Rating					Photo Number
		1-6	7-12	13-24	25-36	37-48	49+	0%	1% - 25%	26%-50%	51%-75%	>75%	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
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		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	
		1	2	3	4	5	6	D	P	F	G	E	

ROW Planting Sites (dot tally):

Dead Trees-Private (dot tally):

***Prompt Attention* (use tree #):**

Address/Intersection

Sample Inventory Instructions: Galveston, TX

General: For each numbered segment, evaluate the right-of-way (ROW) trees on both sides of the street. Only survey trees over 1 inch in diameter. If you have more than 20 trees, use a sheet with blank tree number column and fill in 21, 22, 23... and fill in "Blockside Sheet ____ of ___" at bottom of survey sheet.

Species Code: From list. Write tree name if code not on list. If species is 'unknown,' write code UNKN and take picture to aid identification later.

DBH Class: For ROW trees over 1" at breast-height (4.5'), diameter is measured around the trunk at the narrowest point between 4.5' (DBH) and the ground, but below the lowest fork. If multi-stemmed (i.e. crapemyrtles), add the diameters of the largest three stems (over 1") at DBH. Assign each tree to one of the following classes: 1 (1-6), 2 (7-12), 3 (13-24), 4 (25-36), 5 (37-48), 6 (49+). For palms, assign to class based on feet of clear trunk height (from ground to base of live crown).

Crown Rating: This rating evaluates the current amount of green leaves in the crown of the tree, by percent class:

0% (D): There is no evidence of leaf sprouting anywhere on the tree.
1%-25% (P): There is visual evidence of leaf sprouting, or tree crown has green leaves covering up to 25% of the small twigs in the crown.
26%-50% (F): Tree crown has green leaves covering between 26% and 50% of the small twigs in the crown.
51%-75% (G): Tree crown has green leaves covering between 51% and 75% of the small twigs in the crown.
>75% (E): Tree crown has green leaves covering between 76% and 100% of the small twigs in the crown.

Photo Number: For ROW trees that can't easily be identified, or for trees that require attention by an arborist for safety reasons, take a digital photograph and record the photo number in this space. Do not photograph each tree in the survey, if possible.

ROW Planting Sites: For each blockside, record the total number of planting sites available to plant a medium or large tree, according to the following constraints:

-No overhead powerlines
-Minimum 4-foot wide tree lawn (strip between curb and sidewalk)
-Minimum 25 feet from street corners, traffic signals
-Minimum 10 feet from hydrants, utility poles, or street lamps
-Minimum 5 feet from driveways
-Recommended 30-40 feet from existing large or medium trees

Dead Trees-Private: For each blockside, record the total number of visible dead trees (>6" DBH, <50% canopy) on private property. Segments ending at the corner should be visually divided diagonally in order to count dead private property trees.

__Prompt Attention__: For any tree with a structural defect requiring evaluation by an arborist, record tree number, address or intersection, and observed defect.

TFS April 2009 PDS

Appendix B: List of Species (by DBH Class) and Percent Potential Mortality for each

Common Name (Scientific Name)	Distribution by DBH Class						Tree Count	Percent of Total	# Trees Dead or Dying	Percent Dead or Dying
	1-6	7-12	13-24	25-36	37-48	49+				
Palm (Palm species)	17%	26%	30%	23%	3%		326	32.1%	27	8.3%
Live Oak (Quercus virginiana)	11%	16%	48%	24%	1%		183	18.0%	113	61.7%
Oleander (Nerium oleander)	72%	27%	1%				125	12.3%	49	39.2%
Chinese Tallowtree (Triadica sebifera)	18%	40%	36%	6%			67	6.6%	65	97.0%
Arizona Ash (Fraxinus velutina)	13%	15%	57%	11%	4%		53	5.2%	43	81.1%
Common Crapemyrtle (Lagerstroemia indica)	57%	40%	2%				47	4.6%	36	76.6%
Camphor Tree (Cinnamomum camphora)	23%	36%	36%			5%	22	2.2%	19	86.4%
Pecan (Carya illinoinensis)	24%	35%	35%		6%		17	1.7%	15	88.2%
Southern Magnolia (Magnolia grandiflora)	65%	18%	18%				17	1.7%	15	88.2%
American Sycamore (Platanus occidentalis)		44%	44%	13%			16	1.6%	16	100.0%
Sugarberry (Celtis laevigata)	6%	50%	38%	6%			16	1.6%	12	75.0%
Oak (Quercus species)	8%	46%	38%		8%		13	1.3%	12	92.3%
Chinaberry (Melia azedarach)	10%	50%	30%	10%			10	1.0%	8	80.0%
Chinese Elm (Ulmus parvifolia)	11%	67%	11%	11%			9	0.9%	8	88.9%
Oriental Arborvitae (Thuja orientalis)	75%	25%					8	0.8%	8	100.0%
Mulberry (Morus species)	14%	71%	14%				7	0.7%	5	71.4%
Callery Pear (Pyrus calleryana)	67%	33%					6	0.6%	4	66.7%
Catalpa (Catalpa species)		50%	50%				6	0.6%	5	83.3%
Mimosa (Albizia julibrissin)	60%	40%					5	0.5%	4	80.0%
Yaupon (Ilex vomitoria)	80%	20%					5	0.5%	2	40.0%
Fig (Ficus species)	50%	50%					4	0.4%	0	0.0%
River Birch (Betula nigra)	75%	25%					4	0.4%	4	100.0%
Slash Pine (Pinus elliottii)	25%	50%	25%				4	0.4%	1	25.0%
American Holly (Ilex opaca)		100%					3	0.3%	3	100.0%
Black Willow (Salix nigra)	33%	67%					3	0.3%	3	100.0%
Cherry (Prunus species)	100%						3	0.3%	3	100.0%
Eastern Redcedar (Juniperus virginiana)	33%	33%	33%				3	0.3%	2	66.7%
Norfolk-Island-Pine (Araucaria heterophylla)	100%						3	0.3%	0	0.0%
Orchidtree (Bauhinia purpurea)	67%	33%					3	0.3%	3	100.0%
Unknown Species	33%	33%	33%				3	0.3%	3	100.0%
Carolina Laurelcherry (Prunus caroliniana)	100%						2	0.2%	2	100.0%
Common Persimmon (Diospyros virginiana)		100%					2	0.2%	2	100.0%
Eastern Cottonwood (Populus deltoides)		50%	50%				2	0.2%	2	100.0%
Pittosporum (Pittosporum tobira)	100%						2	0.2%	0	0.0%
Tree-of-heaven (Ailanthus altissima)	100%						2	0.2%	2	100.0%
Australian Pine (Casuarina equisetifolia)			100%				1	0.1%	0	0.0%
Autumn Olive (Elaeagnus umbellata)	100%						1	0.1%	0	0.0%
Baldcypress (Taxodium distichum)			100%				1	0.1%	1	100.0%
Bottlebrush (Callistemon citrinus)	100%						1	0.1%	0	0.0%
Boxelder (Acer negundo)		100%					1	0.1%	1	100.0%
Brazilian Pepper (Schinus terebinthifolius)		100%					1	0.1%	0	0.0%
Cedar Elm (Ulmus crassifolia)		100%					1	0.1%	1	100.0%
Chaste Tree (Vitex agnus-castus)		100%					1	0.1%	1	100.0%
Eastern Redbud (Cercis canadensis)	100%						1	0.1%	1	100.0%
Eucalyptus (Eucalyptus species)	100%						1	0.1%	1	100.0%
Firethorn (Pyracantha species)	100%						1	0.1%	0	0.0%
Japanese Black Pine (Pinus thunbergii)		100%					1	0.1%	0	0.0%
Privet (Ligustrum species)	100%						1	0.1%	0	0.0%
Tamarisk (Tamarix species)			100%				1	0.1%	1	100.0%
Total Number of Right-of-Way Trees Sampled:							**1,015**	**100.0%**		
Total Number of Species Sampled:							**49**			

Appendix C: Loss in Tree Value, by Species

*Loss in value is calculated for each tree in the sample with <50% current canopy using an assumed pre-storm Condition rating of 'fair' (60%), a Location rating of 70% (used for all right-of-way trees), the mid-point diameter for its assigned DBH class, its Species rating, and the Houston/Beaumont 'Basic Price' ($84/square-inch) for a 3-inch caliper specimen, installed and guaranteed for one year. Values for palms are calculated using an average height in 'brown trunk feet' (BTF) and a Basic Price of $50/BTF. Species ratings for species marked with # were determined by the regional urban forester.

	Tree Species	Species Rating #	Average DBH/BTF	Estimated No. Dead/Dying	Average Tree Value*	Estimated Total Value Lost
	Live Oak	100%	19.2"	2,435	$10,190.11	$24,814,945
	Arizona Ash	71%	18.0"	927	$6,355.14	$5,889,112
	Chinese Tallowtree	66%	14.4"	1,401	$3,800.77	$5,324,042
#	Camphor Tree	75%	15.6"	409	$5,069.16	$2,075,612
	American Sycamore	60%	17.0"	345	$4,816.14	$1,660,640
#	Oak	75%	17.3"	259	$6,240.50	$1,613,826
	Pecan	68%	16.2"	323	$4,956.04	$1,602,073
	Sugarberry	65%	15.6"	259	$4,403.63	$1,138,801
	Common Crapemyrtle	80%	6.6"	776	$969.81	$752,391
	Chinese Elm	73%	13.2"	172	$3,527.16	$608,095
	Chinaberry	53%	12.8"	172	$2,395.60	$413,010
	Southern Magnolia	53%	9.3"	323	$1,268.84	$410,162
	Catalpa	73%	13.3"	108	$3,604.53	$388,396
#	Oleander	30%	6.1"	1,056	$306.89	$324,062
#	Palm (all species)	80%	12.1'	582	$184.33	$107,257
	Eastern Redcedar	87%	14.2"	43	$4,881.60	$210,401
#	Mulberry	50%	10.7"	108	$1,596.03	$171,976
	Eastern Cottonwood	67%	14.2"	43	$3,759.40	$162,033
	Baldcypress	80%	18.0"	22	$7,182.13	$154,778
#	Unknown Species	50%	11.7"	65	$1,911.91	$123,608
#	American Holly	80%	9.0"	65	$1,795.53	$116,083
#	Oriental Arborvitae	60%	5.2"	172	$448.88	$77,389
#	Tamarisk	40%	18"	22	$3,591.07	$77,389
	Common Persimmon	65%	9.0"	43	$1,458.87	$62,879
	Black Willow	53%	7.5"	65	$837.08	$54,119
	Mimosa	38%	6.7"	86	$473.82	$40,844
	Callery Pear	60%	5.2"	86	$448.88	$38,695
#	Chaste Tree	80%	9.0"	22	$1,795.53	$38,694
	Cedar Elm	78%	9.0"	22	$1,750.64	$37,727
	River Birch	55%	5.2"	86	$411.48	$35,470
#	Orchidtree	60%	5.7"	65	$548.64	$35,470
	Boxelder	51%	9.0"	22	$1,144.65	$24,668
	Tree-of-heaven	80%	3.0"	43	$199.50	$8,599
#	Cherry	50%	3.0"	65	$124.69	$8,061
#	Carolina Laurelcherry	70%	3.0"	43	$174.57	$7,524
#	Yaupon	70%	3.0"	43	$174.57	$7,524
	Slash Pine	70%	3.0"	22	$174.57	$3,762
	Eastern Redbud	45%	3.0"	22	$112.22	$2,418
#	Eucalyptus	25%	3.0"	22	$62.34	$1,343
			Estimated Totals:	**10,844**		**$48,623,878**