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IN THE MATTER OF THE APPLICATION OF TUCSON ELECTRIC POWER COMPANY FOR APPROVAL OF ITS DEMAND-SIDE MANAGEMENT PROGRAM PORTFOLIO PLAN.	DOCKET NO. E-01933A-07-0401 **INITIAL COMMENTS OF WESTERN RESOURCE ADVOCATES**

Western Resource Advocates (WRA) hereby submits its initial comments on Tucson Electric Power Company's (TEP's) Demand-Side Management (DSM) plan filed on July 2, 2007. WRA's comments address only TEP's Shade Tree Program. Other parties are expected to submit comments on other aspects of TEP's DSM program. We may file additional comments at a later date.

Our comments provide an independent assessment of TEP's shade tree program based on public sources of information.

A. Recommendations

We recommend that the Commission approve TEP's proposed shade tree DSM program. This is a program with a long track record that is likely to be a cost-effective use of DSM funds. It does not need major revisions. However, we do recommend that TEP make several adjustments to the shade tree program to increase its impact and cost effectiveness:

- To increase savings while keeping costs low, consider allowing 3 or 4 trees per house for less energy efficient houses or houses that are likely to use little irrigation water, i.e., houses built before 1980 or with single pane windows or with desert landscaping, while allowing any residential participant to continue to receive 1 or 2 trees, regardless of house and yard characteristics.

- Emphasize placement of trees to shade windows to obtain greater energy savings.

- Focus the monitoring and evaluation effort on obtaining better information on tree maintenance costs, tree mortality rates, and kW and kWh savings.

B. TEP's Shade Tree Program

TEP proposes to continue its existing shade tree program which has distributed about 50,000 trees for residential shade since 1992. Residential customers may receive one or two five gallon trees for planting within 15 feet of the west, south, or east side of the house. In addition, one or more five gallon or fifteen gallon trees can be planted on school grounds or in community housing projects, along streets, and at non-profit facilities. TEP expects that about 90% of the trees would be residential yard trees.

Application processing and documentation are carried out by Trees for Tucson. The Trees for Tucson application form is attached as Exhibit 1. TEP estimates that about 5,800 trees will be planted annually over the period 2008 to 2012.

Table 1 describes commonly planted desert-adapted trees. TEP indicates that mesquites are the most popular trees selected by program participants. McPherson and Dougherty[1] concluded that, to maximize air conditioning energy savings, shade trees for southwestern areas should have a broad spreading form and a dense crown. The trees listed in Table 1 either exhibit this form or approximate this form.

Table 1. Common Desert-Adapted Trees for Urban Sites

Species	Common name	Mature Tree Size	Growth Rate
Acacia farnesiana	Sweet acacia	Small	Fast
Acacia salicina	Willow acacia	Medium	Fast
Cercidium floridum	Blue Palo Verde	Medium	Fast
Cercidium praecox	Palo brea	Medium	Fast
Chilopsis linearis	Desert willow	Small	Moderate
Lysiloma microphylla	Feather tree	Small	Moderate
Olynea tesota	Ironwood	Small - Medium	Slow
Pithecellobium flexicaule (Ebenopsis ebano)	Texas ebony	Small	Slow
Prosopis chilensis	Chilean mesquite	Medium	Fast
Prosopis velutina	Velvet mesquite	Medium	Fast

Sources: Arizona Native Plant Society, Trees for Tucson/Global ReLeaf, "Desert Trees," 1990. *Sunset Western Garden Book*, Menlo Park, CA: Lane Publishing Co., 1988. Author observations.

[1] E. Gregory McPherson and Eileen Dougherty, "Selecting Trees for Shade in the Southwest," *Journal of Arboriculture*, vol. 15, no. 2, February 1989: 35-43.

C. Benefits of Shade Trees

Shade trees in urban areas provide several benefits, including:

- Reduced air conditioning demand in buildings through shading and evapotranspiration, thereby saving energy as discussed in more detail in the following sections.
- Aesthetic benefits for a community that may be capitalized in higher property values.
- Wildlife habitat.
- Sequestration of carbon dioxide.

D. Analytical Method

The Commission's principal test for evaluating DSM programs is cost effectiveness using the total resource cost test or the societal cost test. WRA calculated the present value of net benefits of TEP's shade tree program, taking into account the amount of shade, energy and demand savings from the shade, costs of "installing" and maintaining trees, and avoided utility energy and capacity costs. The net benefits are energy and demand savings minus tree costs, including maintenance and watering costs. Figure 1 summarizes the analytical framework. Details on assumptions are presented below.

E. Energy Savings

To estimate kW and kWh savings from a mature tree, we reviewed residential shade tree studies. Table 2 summarizes estimated savings for mature medium size trees in the desert southwest. The studies measured the effects of 1 to 4 trees per house. The savings reported Table 2 are the average savings per tree, which may differ from the savings from adding one more tree to a yard.

There is a large range in the values of savings estimates. In part, this range is due to assumptions about house characteristics. In general, savings will be greater if shade trees are planted near less efficient homes, such as older homes or homes with single pane windows or more south facing glass.[2] Thus, savings levels could be increased by selecting less efficient homes to receive shade trees. In addition, energy savings will be increased by shading windows.[3]

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[2] In a study of Tucson energy use, McPherson and Dougherty, *op. cit.*, concluded that "Potential energy savings from tree shade were greater for older and less energy efficient homes ..." p. 42.

[3] Shade trees may also increase use of energy for home heating in the winter. Several studies incorporate this effect, but in general the impact of trees on energy for home heating in the Southwest is relatively small compared to the energy savings for cooling in the summer.

Shade Tree Cost - Benefit Framework

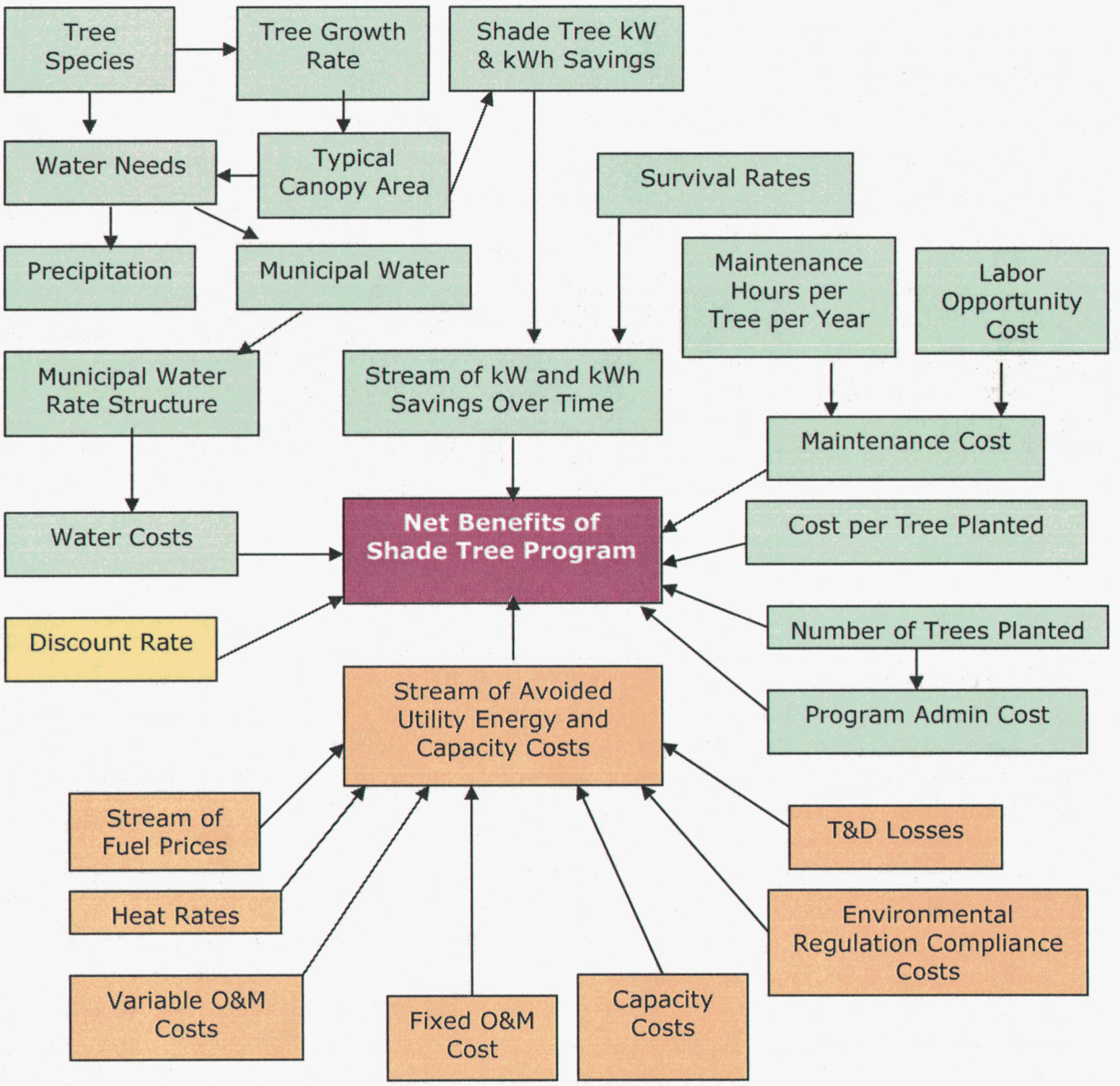

Figure 1

For our analysis, the base case savings level is assumed to be the median of the savings for mature trees shown in Table 2, where the values for the Arizona State Land Department guide are combined into a single observation equal to the average savings for all three orientations. The median savings for mature trees are 214 kWh per year and 0.056 kW of peak demand measured at the customers' premises.

Table 2. Energy Savings Due to Shade Trees

Study	Study Area	Configuration	kWh Savings per Mature Tree per Year	kW Savings per Mature Tree
McPherson, 1993	Tucson	Air conditioning savings due to 1 deciduous tree at west side of energy efficient 2 story home	400 for 24 ft tree	.50 for 24 ft tree
Clark & Berry, 1994, 1995	Phoenix	Residential customer savings in houses that received an average of 3 medium size trees to shade sun-struck sides of houses	270 for average house with dual cooling 319 for inefficient house with dual cooling 12 for average house with ac only 128 for inefficient house with ac only	.007 for average house with dual cooling .12 for inefficient house with dual cooling .017 for average house with ac only .057 for inefficient house with ac only
Akbari & Konopacki, 2005	Tucson	4 deciduous shade trees near south and west walls of 2000 square foot residential buildings	158 for pre 1980 house with electric heat* 99 for 1980 or newer house with electric heat*	.056 for pre 1980 house .046 for 1980 or newer house
Arizona State Land Dept., 2004	Desert Southwest	20 year old medium size residential yard tree (cooling savings): savings reduced to account for tree deaths	388 west orientation 291 south orientation 334 east orientation average = 338	Not reported
Simpson & McPherson, 1996	El Centro, CA	Cooling savings from 2 trees on the west side and 1 on the east side of an energy efficient house	214	.15

References:
E. Gregory McPherson, "Evaluating the Cost Effectiveness of Shade Trees for Demand-Side Management," *The Electricity Journal*, vol. 6. no. 9, November 1993: 57-65.
Kim Clark and David Berry, "Targeting Residential Conservation Measures," *Home Energy*, September/October 1994: 14-15.
Kim Clark and David Berry, "House Characteristics and the Effectiveness of Energy Conservation Measures, *Journal of the American Planning Association*, vol. 61, no. 3, Summer, 1995: 386-395.
H. Akbari and S. Konopacki, "Calculating Energy-Saving Potentials of Heat-Island Reduction Strategies, *Energy Policy*, vol. 33, issue 6, April 2005: 721-756.
Arizona State Land Department, Natural Resources Division, Urban & Community Forestry Section, and Arizona Community Tree Council, Inc., *Desert Southwest Community Tree Guide*, 2004., Appendix A.
James Simpson and E. Gregory McPherson, "Potential of Tree Shade for Reducing Residential Energy Use in California," *Journal of Arboriculture*, vol. 22, no. 1, January 1996: 10-18.

Notes
* The values reported are net savings with winter heating increases subtracted from the air conditioning cooling savings

Energy savings are also affected by the survival of trees planted in the program. We reviewed several studies of urban tree mortality and found a large variation in survival rates.[4] In general, survival of urban trees depends on the location of the trees – street trees tend to have higher mortality rates than trees located in residential yards, for example. Trees may be damaged by construction activity, lawn mowers, and vandalism. Improper transplanting also contributes to high mortality rates. We assumed a base case using the survival rates estimated by the Sacramento Municipal Utility District and we prepared an alternative case in which the annual mortality rate is 3.5%. These survival rates are shown in Figure 2.

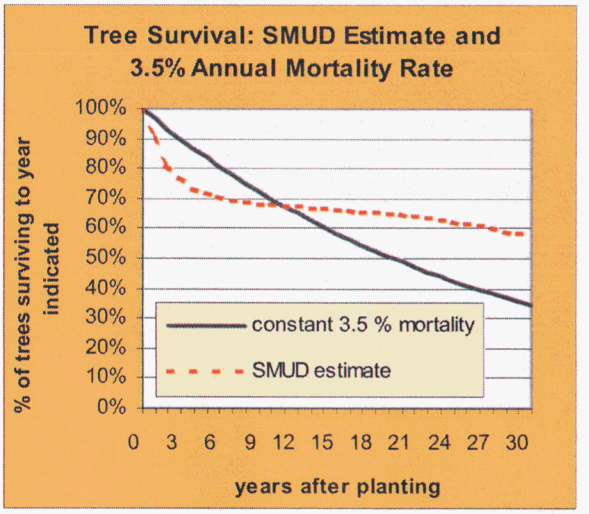

Figure 2

F. Shade Tree Costs

We considered the following costs of a shade tree program for urban residential yard trees:

- **Delivered costs of the tree**. In an e-mail dated September 24, 2007, TEP estimated these costs at $36 per yard tree (tree cost + delivery). Retail prices for 5 gallon trees range from about $17 (sale price) to $37. We used TEP's estimate.
- **Program administrative costs**. TEP estimates these costs at $26,667 per year.
- **Maintenance costs**. For some participants, gardening is a hobby and maintenance costs could be considered to be zero. To be conservative, we valued planting time, regular maintenance of living trees and removal of dead trees based on an estimate of hours needed and on the opportunity cost of homeowner labor equal to the median wage rate in Tucson as reported by the Bureau of Labor Statistics.

[4] Sacramento Municipal Utility District (SMUD), www.appanet.org/treeben/data/growthmortalitydata.asp (accessed September 6, 2007). J. R. Thompson, D. J. Nowak, D. E. Crane, and J. A. Hunkins, "Iowa, US., Communities Benefit from a Tree-Planting Program: Characteristics of Recently Planted Trees, " *Journal of Arboriculture*, vol. 30, no. 1, January 2004: 1-9. David J. Nowak, Miki Kuroda, and Daniel Crane, "Tree Mortality Rates and Tree Population Projections in Baltimore, Maryland, USA," *Urban Forestry and Urban Greening*, vol. 2, 2004: 139-147. David J. Nowak, Joe McBride, and Russell Beatty, "Newly Planted Street Tree Growth and Mortality," *Journal of Arboriculture*, vol. 16, no. 5, May 1990: 124-129. Randall Miller and Robert Miller, "Planting Survival of Selected Street Tree Taxa," *Journal of Arboriculture*, vol. 17, no. 7, 1991: 185-191.

- **Watering costs**. We estimated water usage by starting with water consumption requirements for desert adapted trees in Tucson reported by the Arizona Municipal Water Users Association,[5] adjusted downward to reflect water requirements met by Tucson precipitation (Figure 3). The cost per hundred cubic feet of water supplied by municipal water sources was taken from City of Tucson water rates. The water rates are tiered and we used the lowest tier as typical of residential water use.[6]

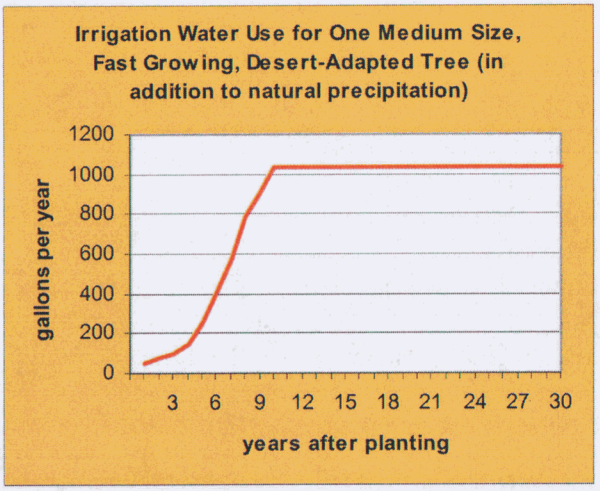

Figure 3

G. Cost Effectiveness

We analyzed the costs and benefits of planting 5,800 medium size, fast growing residential yard trees in one year.[7] The components of the analysis are as follows:

- Trees are planted in year zero and grow over time, reaching maturity in about 10 years, depending on the type of tree.
- A portion of the trees planted in year zero do not survive and the number of living trees diminishes over time.
- Living trees are watered using municipal water supplies. The amount of water depends on precipitation and on the size of the tree in a given year.
- Living trees are maintained by homeowners and dead trees are removed by homeowners.

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[5] Arizona Landscape Irrigation Guidelines Committee, Arizona Municipal Water Users Association, *Guidelines for Landscape Drip Irrigation Systems*, 2001, Appendix J.

[6] The average monthly use of potable water by single family customers was 11.80 CCF in 2006: City of Tucson Water Department, *Annual Report, Fiscal Year 2006*, page 18. The first tier rate block goes up to 15 CCF, suggesting that for the average residential customer, summer use may fall at the upper end of the first tier rate block. Moreover, usage per connection has been declining over time (*Annual Report*, p. 20), further suggesting that many customers fall into the first tier rate block. The rates, translated to dollars per gallon, are $0.001564 per gallon for usage up to 15 CCF (11,220 gallons), and $0.005468 per gallon for usage between 16 and 30 CCF. In addition there is a CAP charge of $0.05 per CCF.

[7] See Table 1 for examples of these trees. TEP anticipates that only a small fraction of the trees would be planted in public spaces, so we did not analyze the cost-effectiveness of those trees.

As noted above, for the base case, we assumed that each tree, at maturity, saves 214 kWh per year and 0.056 kW of peak demand at the customer's premises.[8] Savings are less when the tree is young. Projected savings are shown in Figure 4 for the base case.[9] The base case tree, watering, and maintenance costs are as described above and the base case survival rate is the SMUD schedule shown in Figure 2.

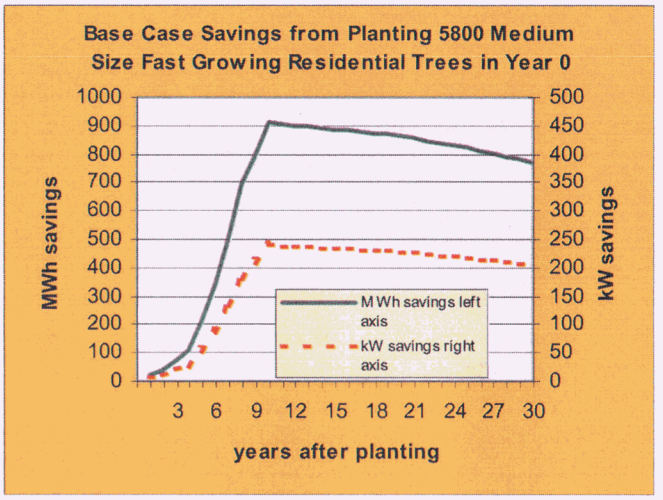

Figure 4

The avoided generation cost resulting from the trees assumes that the marginal generation displaced by DSM is 35% natural gas fired generation and 65% coal fired generation.[10] It is assumed that carbon dioxide emission regulations applicable to power generation will be in effect starting in 2012 and that the allowance price would be $15 per metric ton, escalating at a real rate of 0% per year. The real discount rate for calculating present values is 3%.

We did not estimate benefits of the aesthetic, wildlife or other environmental attributes of urban trees, except for the avoided costs of complying with future greenhouse gas

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[8] The savings estimate used by WRA represents the savings of a mature tree. We analyzed trees planted in a particular year, "grew" the trees over time, and removed trees each year to account for mortality as depicted in Figure 2. TEP apparently averaged kWh savings over all tree sizes, ages, and orientations, then reduced savings for the average tree by 30% to account for "attrition." The resulting savings estimate is 109 kWh per tree per year for a tree planted in the program (Smith testimony, page 12, line 17). TEP assumed no demand savings. Using our framework, the comparable savings per tree planted in the base case (equal to the area under the MWh savings curve in Figure 4 divided by 5800 trees planted divided by 30 years) is 119 kWh per tree per year, which is very similar to TEP's estimate.

[9] The savings in the figure include avoided transmission and distribution losses.

[10] Because the savings are air conditioning savings, TEP would avoid intermediate and peak load generation in the summer. Heat rates of the marginal units are assumed to be 13,024 Btu/kWh for marginal gas generation and 10,216 for the coal portion. O&M costs are from Energy Information Administration, *Assumptions to the Annual Energy Outlook 2007*, Table 39, escalated to 2007 dollars. Avoided capacity costs are based on the sale price of the Sundance plant to APS, escalated to 2007 dollars. Avoided carbon dioxide emissions from the marginal power plant are assumed to be 1000 pounds per MWh for gas generation and 2204 pounds per MWh for coal generation. Natural gas costs are assumed to be $7.17 per MMBtu in 2007 (Energy Information Administration, *Short Term Energy Outlook*, September 2007 projection of natural gas prices paid by the Electric Power Sector), escalating at a real rate of 1% per year. Coal prices are $2.605 per MMBtu (TEP FERC Form 1, 2006, for the Sundt steam plant, escalated to 2007 dollars), escalating at a real rate of 1% per year, based on recent increases in delivery costs.

emission reduction regulations pertaining to power generation. Thus our cost effectiveness evaluation understates societal net benefits.

In the base case, the present value of net benefits over the 30 year time horizon is $287,000, indicating that the tree program is cost effective.

Table 3 presents the results of several sensitivity analyses of the program. Under the cases shown, the program is cost effective.

Table 3. Net Benefits of Planting 5800 Trees in Year 0: Sensitivity Analyses

Case	Present Value of Net Benefits
Base case	$287,000
Base case, but 50% of customers on 2nd water rate block, 50% on 1st block	$177,000
Base case, but constant % mortality rate shown in Figure 2	$127,000
Base case, but savings = 160 kWh per mature tree per year	$52,000
Base case, but maintenance treated as part of gardening hobby, cost = $0	$862,000

H. Program Monitoring and Evaluation

We recommend that TEP or its monitoring and evaluation contractor focus on several issues:

- **Obtaining better information on tree maintenance costs**. If possible, the monitoring and evaluation study should obtain maintenance expenditure information from earlier participants.
- **Obtaining better information on mortality**. For a sample of trees previously planted under this program, determine whether the trees are still alive. Examples of tree survival studies are provided above.
- **Updating kW and kWh saving estimates**. At a minimum, the monitoring and evaluation study should use standard engineering models to estimate energy and demand savings for residential sites in Tucson for mature trees.

I. Conclusions

TEP's shade tree program is cost effective and should be continued. We recommend that the Commission approve TEP's shade tree DSM program. The cost effectiveness of the program may be increased by:

- Targeting less efficient houses to increase kW and kWh savings. Houses might be distinguished on the basis of age (e.g., built prior to 1980 or built in 1980 or later) or on the basis of window characteristics (houses with single pane windows versus houses with dual pane windows).
- Emphasizing to program participants the greater energy savings resulting from locating trees to shade windows.

- Targeting houses with desert landscaping to increase the chances that water costs will be low, given Tucson Water's steeply inclined block rates.
- Allowing more than 2 trees per house to increase total energy savings. Many houses could reasonably accommodate 3 or 4 shade trees on the west, south, and east sides. In particular, we suggest that TEP consider allowing 3 or 4 trees per house for houses built before 1980 or with single pane windows or with desert landscaping, while allowing any residential participant to continue to receive 1 or 2 trees, regardless of house and yard characteristics.

Respectfully submitted this 2nd day of October, 2007.

by:

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Original and 13 copies mailed this 2nd day of October 2007, to:

Docket Control
Arizona Corporation Commission
1200 W. Washington St.
Phoenix, AZ 85007

Electronic copies to service list.

Exhibit 1

Trees for Tucson Application Form

Home Shade Tree Application - September-October 2007 Delivery

In partnership with

Tucson Electric Power
A UniSource Energy Company

Thanks to a **Tucson Electric Power Co.** grant, TEP customers (**includes homes outside city limits**) may be eligible to receive up to 2 trees (3 – 5 ft. tall) for only **$6.00 per tree including delivery** if you agree to plant them to shade your house. Large shade trees can reduce cooling bills, especially if they shade windows and air conditioning units. ***Include check to TREES FOR TUCSON; payment deposited on receipt to reserve trees.***

To qualify, each resident must agree to:

A) Plant trees **within 10-15 feet** of your home on the **WEST (best shade location), EAST (second best) or SOUTH** side of the home to shade it during the hottest months. Planting locations checked when trees delivered.

B) Hold *Trees for Tucson* and *Tucson Electric Power Co.* harmless from all liability associated with tree planting and maintenance.

Resident signature: _____ Date: _____

Name: _____ Phone (hm): _____ Ofc/Cell: _____

Address: _____ Zip Code _____

Will you be out of town in September or October 2007? Yes _____ No _____ (If yes, will call before delivering)

Indicate Your Tree Choices, up to 2 trees per house at $6 each. Prepayment required:

____ **Velvet Mesquite** (moderate growth & shade to 15 ft. tall, 20 ft. wide; thorns; seed pod litter; high pollen; less likely to suffer from wind damage than Thornless/Chilean Mesquite)

____ **Thornless Mesquite** (dense shade, fast growth to 20 ft. tall, 25 ft. wide; seed pod litter; high pollen; proper maintenance needed to prevent wind damage)

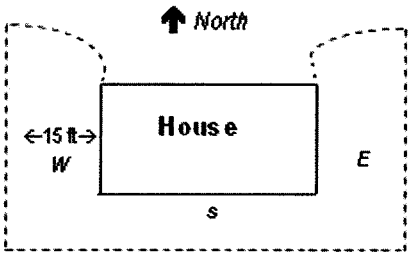
____ **Desert Willow** (modest shade; moderate growth to 15-20 ft. tall and wide if watered well; low pollen; no thorns; pink flowers; drops leaves in winter, best choice to plant on south side to let winter sunlight in)

____ **Willow Acacia** (fast growth to 25 ft. tall, 15 ft. wide; moderate-high pollen; leaf litter; no thorns; frost sensitive; good for planting in narrow spaces)

____ **Blue Palo Verde** (moderate growth to 20 ft. tall, 20 ft. wide; high pollen; thorns; attractive yellow flowers; seed pod litter)

YOU MUST COMPLETE THIS SKETCH TO QUALIFY:

Mark with an "X" where you will plant trees in the15-foot Planting Zone →



NOTE: Plant trees at least 10 ft. from sewer lines, 5 ft. from water lines, and 3 ft. from other utility lines. Do not plant under overhead lines. Do not plant in public right-of-way without permit & Blue Stake clearance (1-800-782-5348). Planting & maintenance instructions provided with trees.

Total cost of trees to be delivered ($6 each, up to two trees per home) . . . . . $ _____

Please send _____ Trees for Tucson t-shirts ($10 each) – Sizes: _____ Select: white or light grey _____

Please send _____ Trees for Tucson posters ($5 each) . . . . . _____

I am making an additional donation to help provide even more trees for community planting projects! _____
(Trees for Tucson is a program of Tucson Clean & Beautiful, Inc., a nonprofit organization; additional contributions are tax-deductible)

☆ **Total enclosed $** _____

_____ **Please send information on Tucson and Southern Arizona Tree Tours** ($40 – includes lunch and transportation)

_____ **Please contact me regarding volunteer opportunities to remove invasive plants from natural public preserves**

***Send application to*: TREES FOR TUCSON, P.O. Box 27210, Tucson, AZ 85726-7210 - 250-8220 or 791-3109**