

Green Infrastructure, Urban Forest and Air Quality in Phoenix, Arizona



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Philip McNeely
City of Phoenix

What's So Green About Green Infrastructure?

- ❖ Stormwater becomes a resource, not a waste
- ❖ Natural living systems support urban tree canopy
- ❖ Treat/remove pollutants
- ❖ Reduce erosion from runoff
- ❖ Reduce costs of gray infrastructure
- ❖ Shading and cooling
- ❖ Traffic calming effects
- ❖ Aesthetics / property value



Curb cut for street runoff



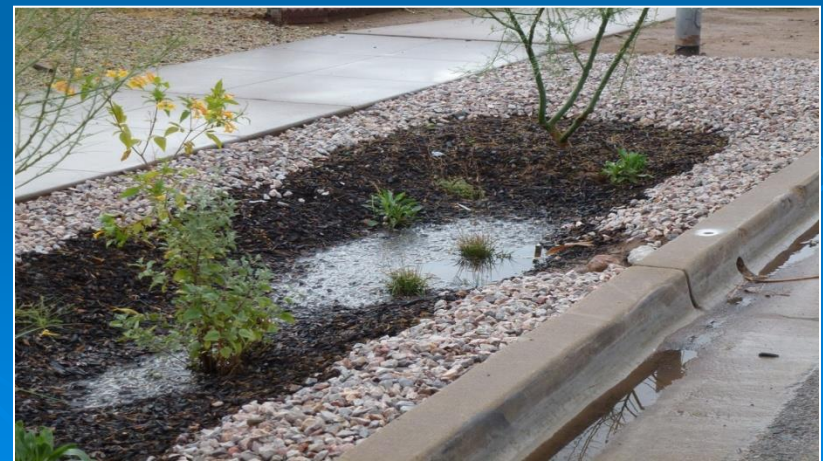
Traffic Chicane

Green Infrastructure

- ❖ **Managing stormwater close to its source**
 - **Permeable Paving**
 - **Reduce or disconnect paved surfaces**
 - **Traffic chicanes or “bump outs”**
 - **Curb cuts / curb cores**
 - **Bioretention basins/ Vegetative Swales**
 - **Rainwater Harvesting**
 - **Preserving/recreating natural systems**

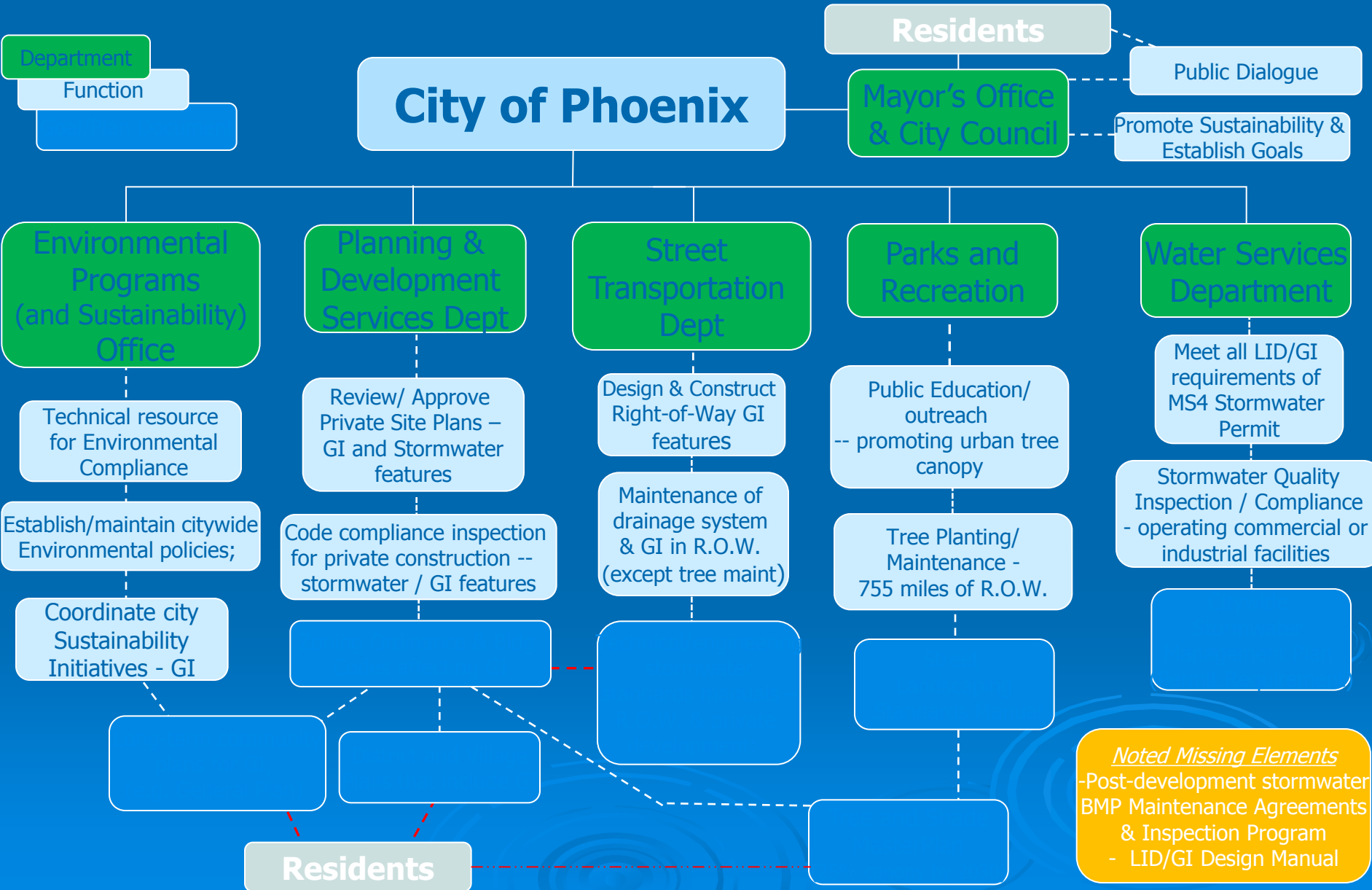


Curb Core for Street Run-off



Vegetative Swale - Primera Iglesia, Phoenix

Organizational Structure – Green Infrastructure



Significant GI Barriers – Political/Municipal

❖ Code and Technical Design Standards - Omissions or Barriers

- Most barriers in city code and technical design standards are addressed on case-by-case waiver basis.
- No GI/LID Design Manual exists
- Phoenix requires new development to retain onsite all stormwater from the 100-year 2-hour storm event (and first flush or 0.5 inch for redevelopment). ***Perception that this already exceeds green infrastructure intent. (from stormwater perspective.***



Significant GI Barriers – Environmental

- ❖ **Desert climate with extreme heat, limited rainfall, long periods of no rain at all, poses some unique barriers:**
 - Perception that some GI like rainbarrels, rain gardens, and green roofs have limited applicability or payback benefit, so are not worth the investment.
 - Difficulty establishing vegetation/trees in swales or bioretention areas; generally need costly supplemental irrigation first 2 years to get established, permanent irrigation needed for best appearance.



What's Next: Green Infrastructure and City Code



EPA Grant Awarded 2012 - \$35,000

❖ GI Code Barriers and Recommendations

- Develop Green Infrastructure Design Manual
- Implement post-development inspection program for stormwater management “facilities” (retention basins, etc.)
- Update Street Landscape Standards and STR Planning & Design Guidelines with GI templates
- Adopt Tree Protection Ordinance

Major Green Infrastructure Projects

Taylor Mall at Arizona State University (ASU) Downtown Campus

- 2010 Right-of-way project
- Partner: ASU
- Vegetated bio-retention basins
- Curb cuts
- Multi-modal emphasis – bicycle and pedestrian
- Curb bump-outs / chicanes
- Pervious pavers: on-street parking areas.



Major Green Infrastructure Projects

Civic Space Park - Downtown Phoenix – (2008)

- Pervious concrete – provides root zone irrigation
- Geo-grid grass pavers
- 100% onsite stormwater retention or reuse – rain gardens/terraces
- Urban tree canopy – 71% shade at maturation
- Sustainability bonus features
 - Historic building reuse
 - Constructed shade structures w/ solar panels on top
 - LED lighting



Air Quality Criteria Pollutants

❖ Clean Air Act Amendments Designated:

- 6 Criteria Pollutants
 - Carbon Monoxide (Phoenix has met since 1992)
 - Ozone (in violation levels continually lower)
 - Particulate
 - PM-10 coarse particulate (met the standard in 2014)
 - PM-2.5 fine particulate (continues to meet, but close to violation)
 - Lead (always met)
 - NO₂ (always met)
 - SO₂ (always met)

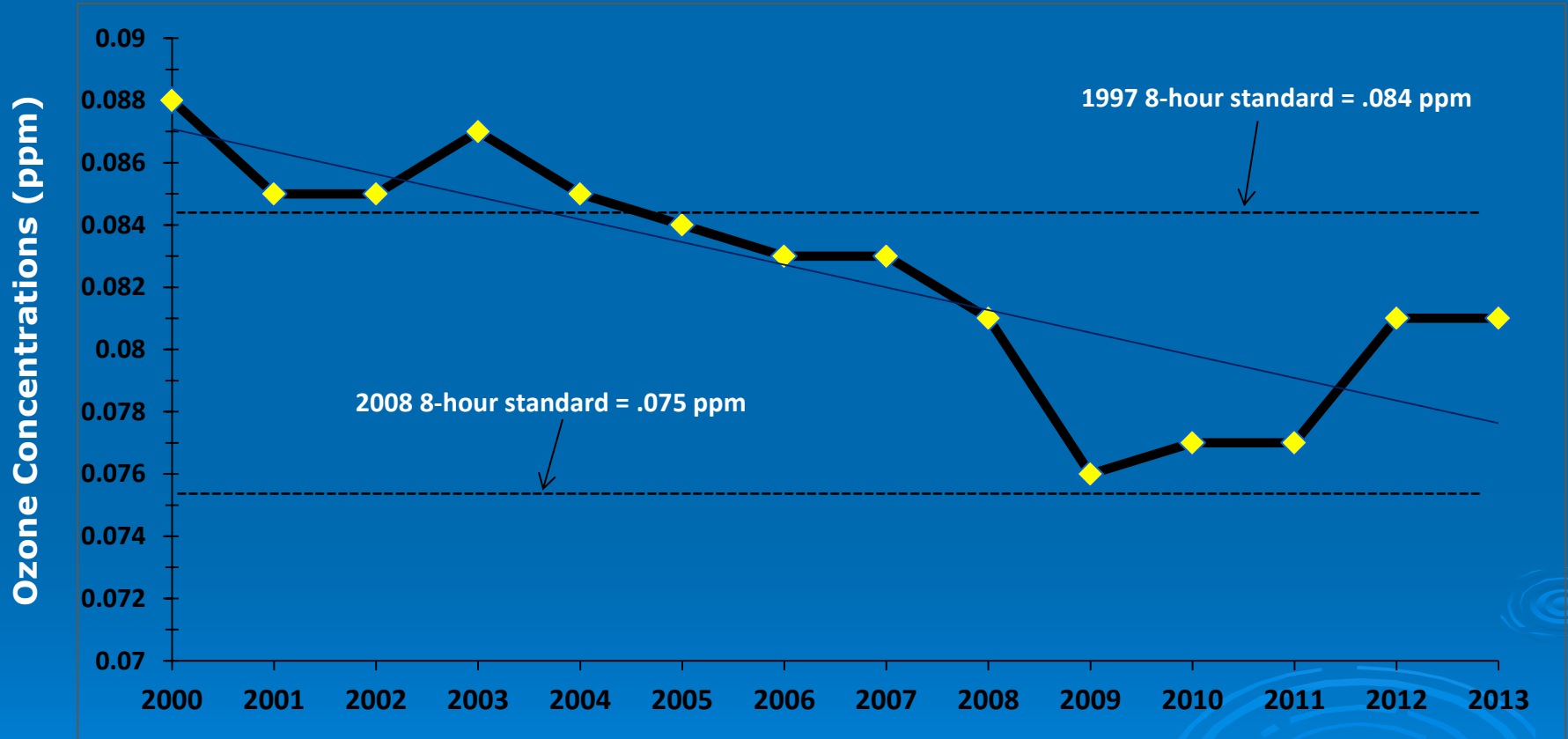
Maricopa County Air Monitors

18 out of 24 are PM-10



Eight-Hour Ozone Monitoring Data

Highest 3-Year Average of the 4th Highest 8-Hour Ozone Concentration in the Maricopa County Nonattainment Area

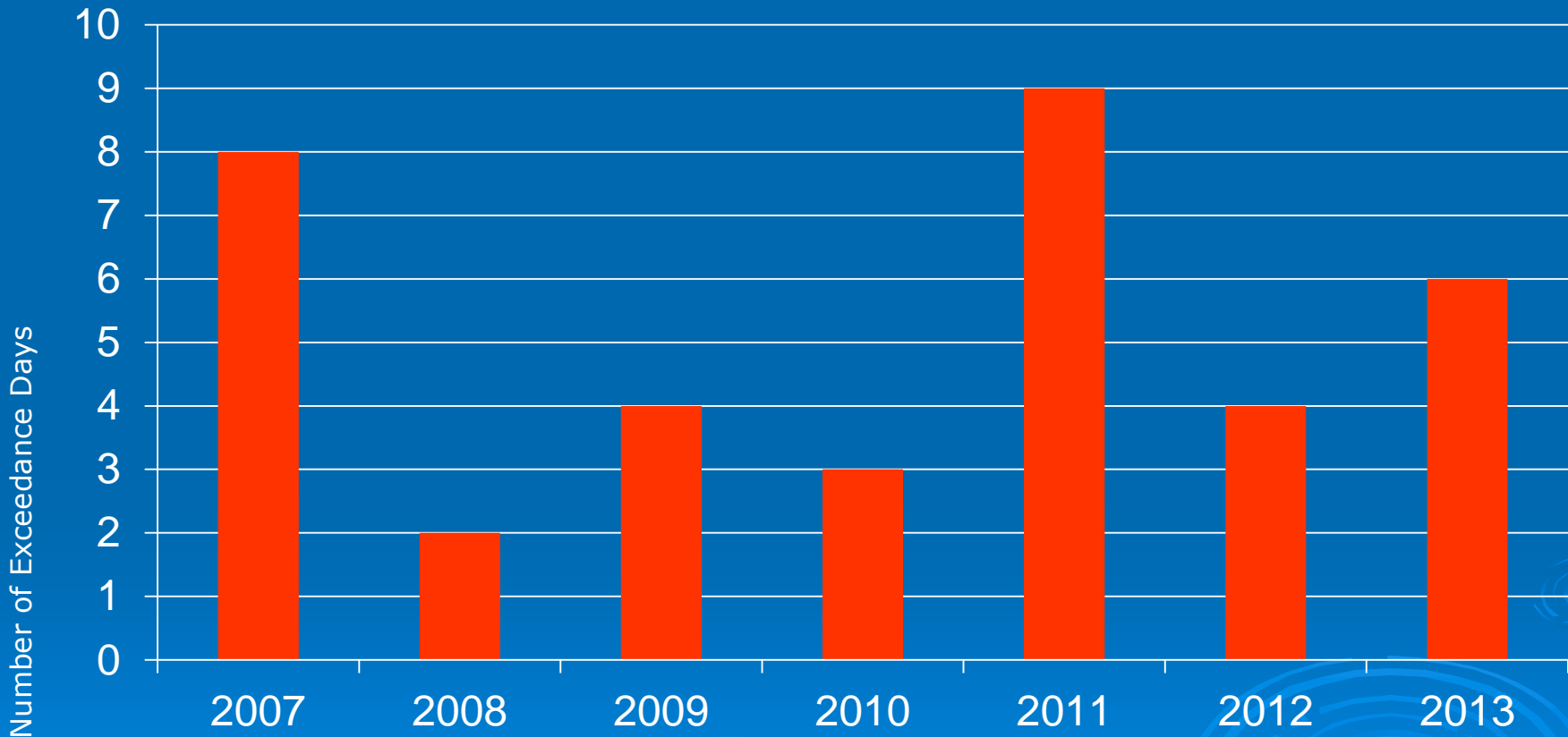


Ozone Reduction Measures

- ❖ **Marginal Non-attainment area for Ozone**
- ❖ **Control Measures:**
 - **Vehicle Inspection Program**
 - **Clean Burning Gasoline**
 - **Stage II Vapor Recovery (expiring)**
 - **Travel Reduction Program**
 - **Outreach (do not refuel during daylight)**

PM-2.5 Monitoring Data

Number of 24-Hour PM-2.5 Exceedance Days in Maricopa County and the PM-10 Nonattainment Area

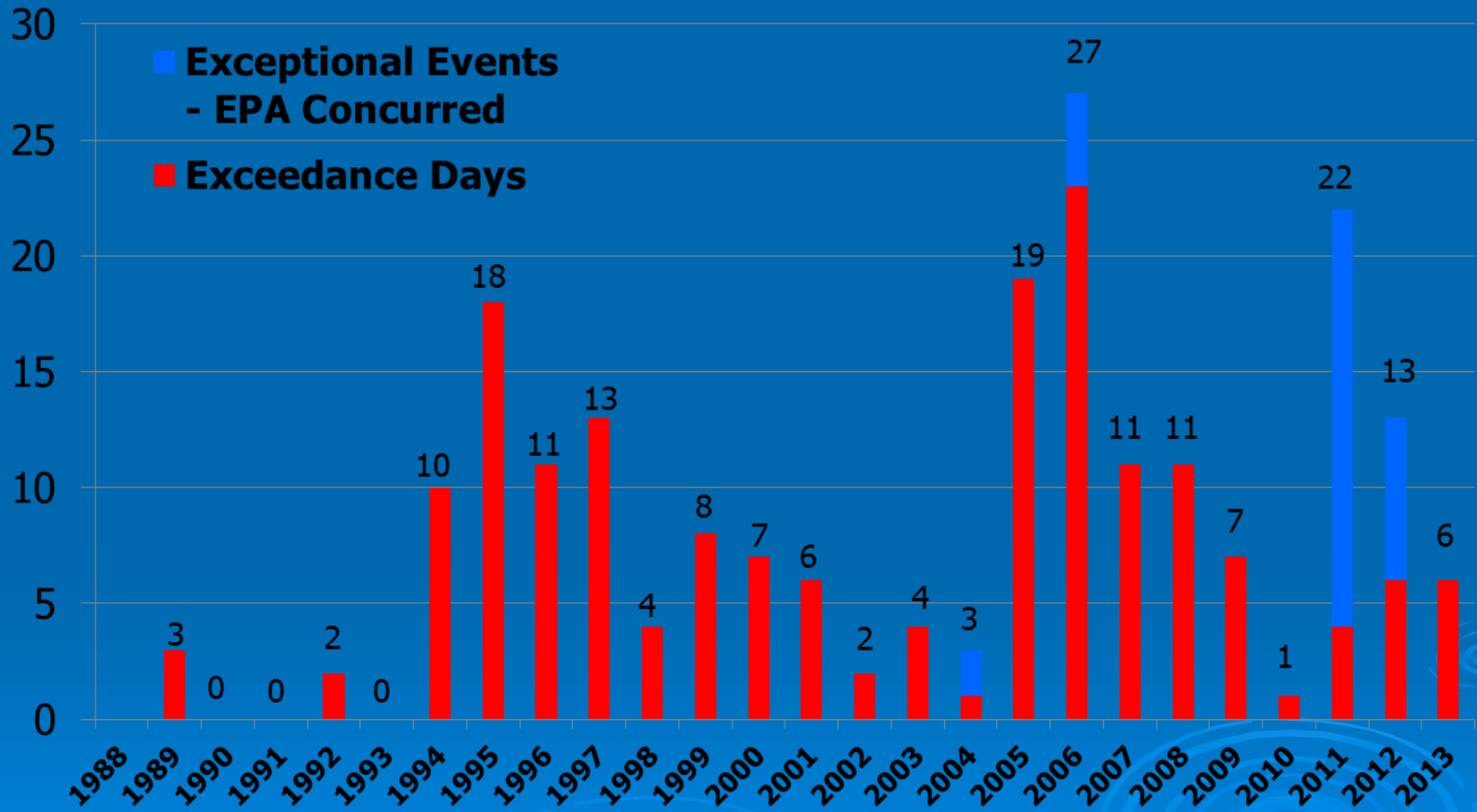


PM-2.5 Measures

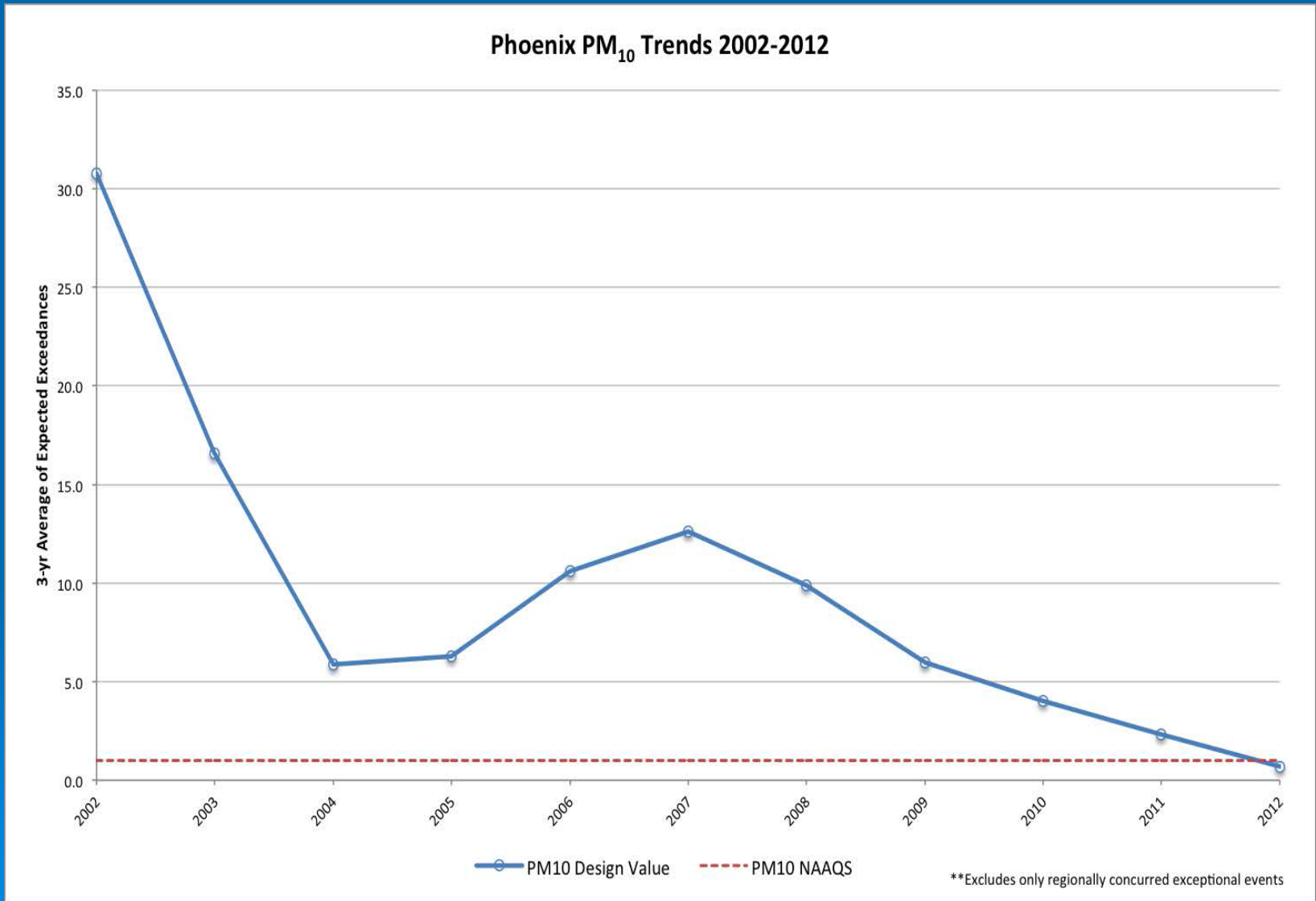
- ❖ **County-issued “No Burn Days”**
 - City broadcasts emails to staff
- ❖ **Increased County outreach in winter**
 - City supports effort
 - News stories on the City’s Inside Phoenix webpage
 - Channel 11 stories & interviews

PM-10 (Dust) Monitoring Data

Number of 24-Hour PM Exceedance Days
in Maricopa County and the PM-10 Nonattainment Area



Phoenix Meets the PM-10 Standard



Phoenix Meets the PM-10 Standard

- ❖ **2014 - EPA Confirms Phoenix has met the Coarse Particulate PM-10 standard**
 - Particulate Plan Submitted 2012 w/ 53 measures
 - Rule 310 - Construction Dust
 - Rule 316 Sand & Gravel Operations
 - Paved parking code enforcement
 - Vacant Lot Stabilization
 - PM-10 Efficient street sweepers
 - Ag BMPs
 - Maintenance Plan in development to obtain attainment status (20 year window)
 - Exceptional Event dust storms don't count against area

Phoenix Dust Storm



Phoenix Dust Storm



What is the Urban Forest?

- ❖ The collection of trees growing with a city, town or suburb (large numbers of people and artificial surfaces).
- ❖ All vegetation, public and private.
- ❖ The human - forest interface.





The Tree and Shade Master Plan

- <http://www.phoenix.gov/parks/urbanforest.html>



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Urban Forest Sustainability

A large tree with yellow-green foliage is the central focus of the image. It is situated in an urban environment, with a fountain and a street lamp visible in the background. The sky is clear and blue. The tree's shadow is cast on the ground in the foreground.

Four characteristics:

- ❖ Generates net benefits
- ❖ Provides services rather than goods
- ❖ Requires human intervention
- ❖ Majority is on private land

Benefits of Trees: Solution Multipliers



A low risk, high-yield investment for the community

- ❖ Water quality, storm runoff
- ❖ Air quality, carbon sequestration
- ❖ Energy costs
- ❖ Property values
- ❖ Business
- ❖ Community safety and livability

Average ROI of \$2.23 in the Phoenix area

McPherson et al, 2004

Key Findings (Summary)	Phoenix, AZ	El Paso, TX	Las Cruces, NM	Albuquerque, NM
Number of Trees (est.)	3,357,000	1,504,000	320,000	1,846,000
Size Land Area	519 sq. mi (1344 sq. km) 332,160 acres	256 sq. mi (663 sq. km) 163,840 acres	47 sq. mi (122 sq. km) 30,080 acres	181 sq. mi (469 sq. km) 115,840 acres
Tree Cover	9.7% - 13.6 trees/acre	5.9% - 14.9 trees/acre	4.5% - 11.4 trees/acre	14.3% - 21.8 trees/acre
Most Common Species	Velvet mesquite 9.6% California palm 7.4% Sweet acacia 6.7%	Italian cypress 24% Afghan pine 10.6% Mexican fan palm 6.5%	Italian cypress 19.4% Desert willow 14.7% Afghan pine 9.9%	Siberian elm 16.8% Desert olive 6.5% Desert willow 6.2%
Percentage of trees less than 6in DBH	44.10%	53.40%	65.10%	56.20%
Pollution Removal	1,880 tons/year (\$7.89 Million/year)	403 tons/year (\$294 thousand/year)	126 tons/year (\$339 thousand/year)	493 tons/year (\$1.44 million/year)
Carbon Storage	339,000 tons (\$24.1 Million)	105,000 tons (\$7.46 million)	21,700 tons (\$1.55 million)	302,000 tons (\$21.5 million)
Carbon Sequestration	36,300 tons/year (\$2.59 million/year)	8,460 tons/year (\$602 thousand/year)	1,800 tons/year (\$128 thousand/year)	12,900 tons/year (\$921 thousand/year)
Oxygen Production	90,100 tons/year (\$0 /year)	16,300 tons/year (\$0/year)	3,690 tons/year (\$0/year)	28,400 tons/year (\$0/year)
Building Energy Savings	\$22.2 million/year	\$3.02 million/year	\$651 thousand/year	\$4.35 million/year
Avoided Carbon Emissions	\$2.87 million/year	\$431 thousand/year	\$87.3 thousand/year	\$589 thousand/year
Structural Values (replacement value)	\$4.23 billion	\$1.7 billion	\$280 million	\$2.62 billion

Urban Heat Island

The replacement of natural land surfaces with materials that retain heat.

- ❖ Dealing effectively with the UHI requires a diverse set of solutions incorporating:
 - Cool and pervious pavements
 - Cool roofs
 - Urban forestry
- ❖ Adaptive and mitigation activities
- ❖ Good design and thoughtful planning

Valuation examples

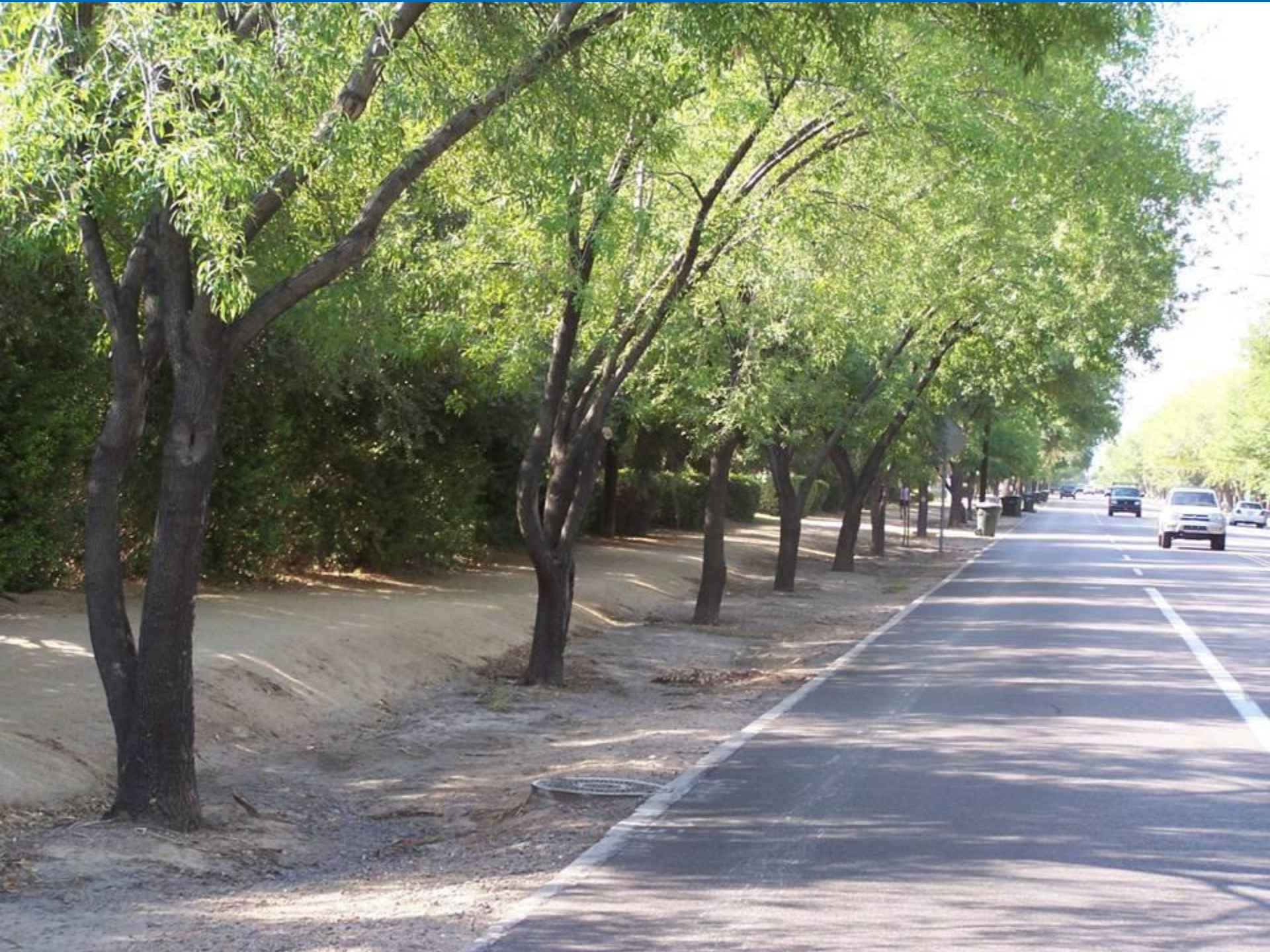
- ❖ **Street Landscape medians:**
 - 10,600 trees, palms, tall cacti
 - Appraised replacement value @ \$5.4 M
- ❖ **Encanto Park:**
 - 1760 trees and palms
 - Appraised replacement value @ \$6.1 M
 - Annual benefit value @ \$75.7 K
- ❖ **Trees in street landscape/parks/facilities:**
 - 92,845 trees
 - \$5.6 M annual benefit to the community

Right Tree Right Place

- ❖ Poor planting choices lead to problems and expense years after installation (maintenance/removal/replacement)
- ❖ Poorly pruned trees to “fit” the location
- ❖ Select for establishment and natural growth and development
- ❖ Design with mature plant development in mind
- ❖ Remember root development, not just branches









PHOENIX MUSEUM

Conclusions

Green Infrastructure & Urban Forests

- ❖ Should be considered as mitigation strategies for stormwater management, air quality, and urban heat island
- ❖ Provide significant ROI and an annual benefit
- ❖ Should be valued and funded as other infrastructure projects