CENTER FOR HOUSTON'S FUTURE

The Center for Houston's Future advances the Houston region as one of the top ten global communities in which to live and work.

Cover photo provided by Commissioner Ed Chance's Office, Montgomery County

Counting on Quality of Place
Air Quality, Parks & Trails and Trees

Table of Contents

2 • Executive Summary

4 • Air Quality

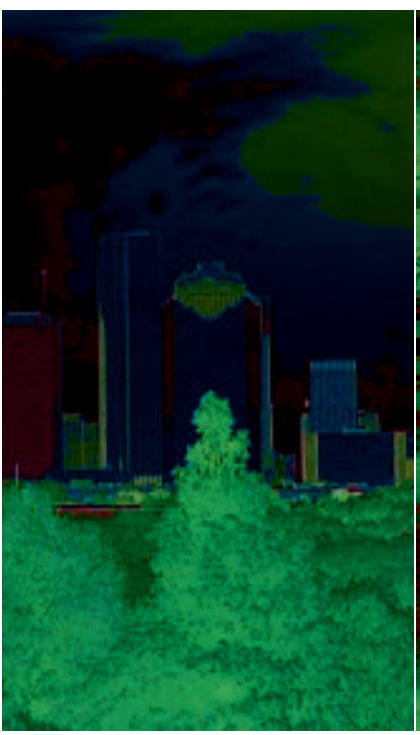
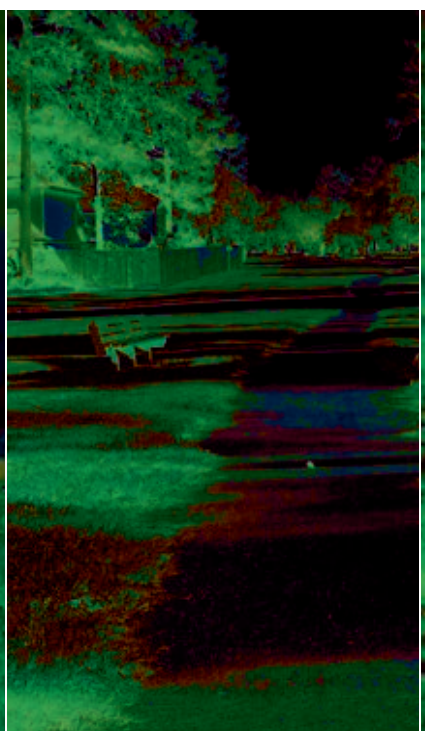
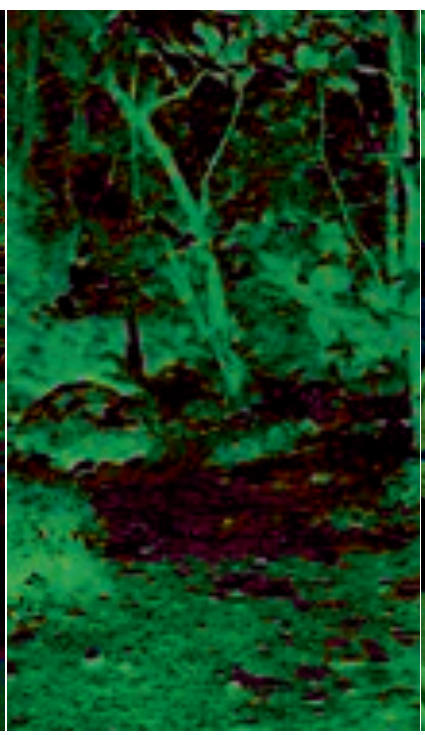
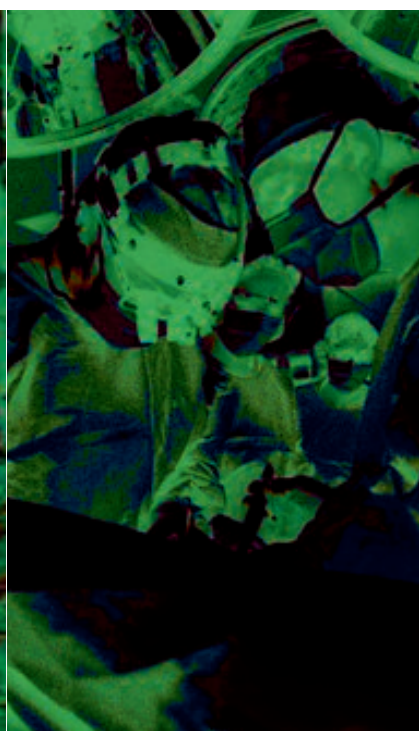
16 • Parks & Trails

28 • Trees

39 • The Health Impacts of Air Quality, Parks & Trails, and Trees

46 • Appendices

55 • Acknowledgements

Executive Summary

Keeping a Promise

In December 2007, the Center for Houston's Future made a promise to monitor and report on essential Quality of Place Indicators to citizens of the greater Houston region. The Center's 2007 publication, titled *Counting on Quality of Life: An Environment Indicator Report* set a benchmark on nine initial indicators: air quality, billboards, green buildings, litter & graffiti, parks & trails, tax delinquent/abandoned lots, trees, water quality and resource use.

Since many of the indicators do not change significantly from year to year, the Center determined to update three indicators per year. In so doing, each would be updated during a three year cycle. This document is the first step in honoring that promise.

These indicators are essentially the framework for regional sustainability. They help to answer some very important questions as the area moves squarely into the 21st Century. What makes one region thrive while another declines? What draws newcomers to a place and convinces them to stay? What are the critical components of a prosperous region? What makes a place home? This study then provides specific answers to the following questions: Is progress being made to improve air quality? Is the region adding park land that is accessible not only to current residents but also to new arrivals? How healthy is the region's tree canopy?

Answers to these questions and others of a similar nature are the focus of ongoing research by the Center and its collaborators. This report summarizes three critically important indicators that a place must have to be a desirable place to live, work and play. Indicators are important dimensions of a unique set of attributes that, taken collectively, place the greater Houston region in a unique position to thrive into the mid-21st Century and beyond.

An Expanded Scope

Because the 2009 Report focuses on a third of the indicators examined in 2007, the Center elected to study this set of indicators in greater depth. Every attempt was made to provide data over 10 years to indicate trends over time. In addition to looking back 10 years, two counties and four cities were added to the study. In 2007, only Houston and Harris County were studied. In 2009, Ft. Bend County, including Sugar Land and Rosenberg, and Montgomery County, including Conroe and The Woodlands, were added.

In addition to longitudinal data and an expanded geographical scope, the 2009 Report adds another important dimension: health. The health implications and effects of each indicator on the region's population is explicitly examined. After all, how Quality of Place Indicators affect the health and well-being of people is the real test of the sustainability of a region.

At a Glance: 2009 Regional Findings

What is the state of Air Quality in the region?

In 2009, air quality in the Houston area is poised to be in compliance with 1997 ozone standards and Milby Park, a previously listed 'watch site' has been delisted. This statement could not have been made in the 2007 Report and is a particularly significant accomplishment at a time of increasing growth. However, despite this success and including the hard work and considerable expenditures by industry, Houston's overall air quality remains among the nation's worst. Many challenges remain, some of which will become even more difficult since the Environmental Protection Agency has signaled it will tighten some standards and will add more compounds to the list of regulated chemicals.

What is the state of Parks & Trails?

There has been little change in park acreage within Houston and Harris County between 2007 and 2009. In the absence of a common regional standard for parks, this study and many cities have adopted a national standard of 20 acres per 1,000 residents. This standard was adopted by Harris County in 2001. None of the counties studied reach this standard.

As for providing access to parks and trails, The Woodlands, a master planned community provides access within walking distance, (i.e. one-quarter mile the national standard), to 91% of its population. Sugar Land was second providing access to 56% of its population. Since 2007, the increase in park acreage has been minimal. However, during the past decade many public-private and public-public partnerships have evolved to provide new support to existing parks and trails. The multi-county Spring Creek Greenway project is a noteworthy example.

What is the state of Trees?

Since the 2007 Report, additional data on tree canopy shows that the region continues to lose significant tree cover, though at a somewhat slower rate than between 1992 and 2000. Between 1992 and 2005, 680 square miles of tree canopy was lost, primarily due to new development. Six hundred eighty square miles is roughly the size of the city of Houston. Since 2005 the region experienced Hurricane Ike which literally decimated the tree population on Galveston Island. The island lost many of its 100 year old live oaks, most of which were planted after the Great Storm of 1900.

Meanwhile, since 2000 the trend has been a steady increase in the number of trees planted by government agencies, volunteer organizations, and individual citizens. Voices are also being heard in city hall and in the commissioners' courts in favor of tree planting and tree preservation ordinances.

What are the health impacts of Air Quality, Parks & Trails and Trees?

Each of these indicators has a huge effect on the health of the region's residents. Most people are aware that when air quality is bad, it exacerbates respiratory diseases, and inhibits a child's ability to grow healthy lungs, and causes cancer. Research money is needed to study specific areas and neighborhoods that may be at risk for all three indicators, but one neighborhood was studied by the University of Texas School of Public Health for the effects of air quality on its residents. The study assesses the risk of 1,3-butadiene, a known carcinogen, in a neighborhood near the Houston Ship Channel. Researchers found a 56% increased risk of acute lymphocytic leukemia among children residing within two miles of the Houston Ship Channel as compared with children living more than 10 miles away.

Adequate access to parks, trails and open space are commonly known to increase activity rates and reduce obesity. Trees and greenery have been shown to increase students' ability to learn and reduce their anxiety. They have also been shown to reduce the time required for healing following surgery or serious illnesses.

Fortunately, much progress has been and is being made in each area thanks to passionate citizens, committed government officials and regulators. A huge challenge remains. Fortunately, Texans love nothing better than a challenge; they will rally and get it done.

Chapter 1: AIR QUALITY

Authors: Brigham Daniels, Assistant Professor
and Holly Reuter, Research Fellow,
University of Houston Law Center

Executive Summary

While Houston's air quality is among the nation's worst, significant progress has been made during the past 10 years. The Environmental Protection Agency (EPA) and the Texas Commission on Air Quality (TCEQ) are the two agencies responsible for setting standards for and monitoring air quality. This report presents data on ozone, fine particulate matter and two air toxins: benzene and 1,3-butadiene, from 1985 to 2008.

Air quality, particularly the ozone level, has improved even as the population, the number of miles driven, and industrial capacity have increased. The improvements in ozone levels at a time of increasing growth for the region represent a significant accomplishment. Houston is poised to demonstrate that it will have met the 0.08 parts per million per volume (ppmv) 8-hour ozone National Ambient Air Quality Standards (NAAQS) by the end of 2009. To meet this standard, regional monitors need to record 84 parts per billion per volume (ppbv) or less of ozone attainment. Several sites, previously listed as 'watch sites' have been delisted, including Milby Park, and others are being considered for delisting.

Fine particulate matter, an array of small particles that can easily penetrate the lungs and contribute to 'haze', has been problematic, hovering just below the standard of 15 micrograms per cubic meter. Between 2006-2008, the greater Houston region fell out of compliance.

Despite recent successes, there is much to be done. Further, the EPA continues to monitor and reset air quality standards to new and lower acceptable levels.

At the outset it should be noted that this report does not cover the much discussed pollutants - greenhouse gases. As the federal government prepares to regulate greenhouse gases, the prospective regulations will have an impact on Houston's carbon-intensive economy and auto-dependent way of life. While it seems likely that greenhouse gases will be considered in future Center for Houston studies, at this time, there is insufficient data readily available to address these pollutants accurately.

Why is air quality an important component of Quality of Place?

The dangers of poor air quality are well known. In the short term, bad air quality can lead to shortness of breath, increased allergies, and exacerbated asthma. In the long term, it can affect overall health, impair the ability of children to develop healthy lungs, increase the chances of respiratory and lung diseases, and even lead to cancers and mortality.

The region's poor air quality is not only a health issue, but also an economic one. While not all types of economic activities contribute to air quality problems, many do. The greater Houston region's oil, gas, petrochemical and shipping-based economy contribute to air pollution along with the countless miles driven every day by those living and working in the region. The region's continued suburban growth and sprawl further impacts air quality. Houston's reputation for urban sprawl and poor air quality goes beyond bad air and its health impacts; it is a barrier to attracting and keeping companies in the area. Thus, for both economic and health reasons, it is essential that the greater Houston region come together to improve its air quality.

Ozone

Ozone, more commonly known as smog, is produced by vehicles and industrial businesses. Ground level smog causes respiratory problems, stunts lung development, and aggravates existing conditions of the lungs.[i] It also degrades the natural environment, damaging the Houston areas valuable ecosystems.

Fine Particulate Matter

Fine particulate matter consists of a wide array of small particles and liquid droplets,[ii] including construction site dust, automobile exhaust, industrial emissions, and burning fossil fuels. Understandably, particulate matter aggravates asthma and heart and lung diseases.[iii] Particulate matter also adds to the haze seen in the Houston area and affects the diversity of local wildlife habitats.[iv]

Air Toxics

The really hazardous air pollutants are also known as air toxics. They are present in the greater Houston area because of the population's inordinate use and dependence on the automobile and the presence of a robust petrochemical industry in Houston. The tradeoffs associated with such pollutants are significant and often translate to an increased risk of very serious illnesses, like cancer, for those with prolonged exposure. Specifically, two hazardous pollutants are of particular concern to the region: benzene and 1,3-butadiene.

Standards for Air Quality

While most Houstonians would undoubtedly agree that clean air is important and that some level of air pollution is acceptable to sustain economic activity, where to draw the line is not entirely clear. As a starting point, polls published by Dr. Stephen Klineberg in The Houston Area Survey, *Regional Perspectives* by Rice University, have consistently shown that area residents are not happy about the current air quality and are aware that difficult choices must be made to improve it.[v] However, while clean air is desirable, the debate must focus on tradeoffs. What are our options? What are the tradeoffs? What are we willing to give up for cleaner air?

Without a clear community goal, this study will rely on the regulatory standards used by the EPA and the guidelines developed by the TCEQ. Whether or not a prospective community goal would seek legal compliance with the Clean Air Act or the TCEQ's monitoring guidelines, this information is helpful on two levels. First, failing to live up to the health-based federal standards for air pollutants comes with serious consequences, including jeopardizing public health and welfare. In addition, failure to meet these standards can result in fines, increased regulatory burdens, and the potential loss of federal highway funds. Understanding the community's air quality, as compared to federal standards and state benchmarks, provides some indication of how the greater Houston region performs against other areas around the country.

How can progress be measured?

TCEQ collects and makes available robust data on the region's air quality. This report will look at the data collected for ground level ozone, particulate matter, and two hazardous air pollutants that are largely associated with Houston region's petrochemical industry. Incidentally, those pollutants pose the largest threats to quality of place and human health in the region. While the data is not without its faults, the TCEQ monitors some of the larger sources of pollution on a real time basis and therefore has data that can be easily aggregated, in some instances, on an hourly or daily basis.

Monitoring Stations

The consensus on monitoring stations is the more, the better, as they provide critical data. While there are significant numbers of monitoring stations in the region, there are some rural and suburban areas that have few or no monitors. For example, Fort Bend County received one ozone monitor in 2008; Liberty and Waller Counties have no monitors. Hazardous air pollutants are monitored in some places where toxic air pollutants would be expected to pose problems but not in others, even though air pollution moves freely across the region. To address this issue, the TCEQ routinely conducts air quality investigations in the Houston area using mobile monitoring vans with specialized instrumentation to measure air pollutant concentrations and to identify areas that warrant further investigation. In some instances, the TCEQ has deployed an air toxics monitoring site such as the Jacinto Port canister, as a direct result of mobile monitoring investigation findings. This analysis of the pollutants is limited to the data collected.

TCEQ acknowledges a need for additional monitors, and maintains that current monitors in at-risk communities adequately calculate air quality. The ambient air monitoring network has changed significantly over the past 25 years. The number of ozone monitoring sites has almost doubled. Most sites monitor many types of pollutants. The location of certain monitoring sites has changed as data needs have changed.

What is the current situation?

The EPA has set National Ambient Air Quality Standards (NAAQS) for seven pollutants that are present throughout the United States that scientists, medical professionals and EPA itself deem to adversely impact human health and the environment. The Houston region meets the requirements of five of those seven pollutants: carbon monoxide, lead, nitrogen dioxide, particulate matter[x] and sulfur dioxide. Recently the region has technically fallen out of attainment for the annual particulate matter 2.5 ($PM_{2.5}$)standard, and has historically failed to meet the ozone standard. However, as stated earlier, Houston will likely be in attainment for the 1997 8-hour ozone standard for the years 2007-2009.

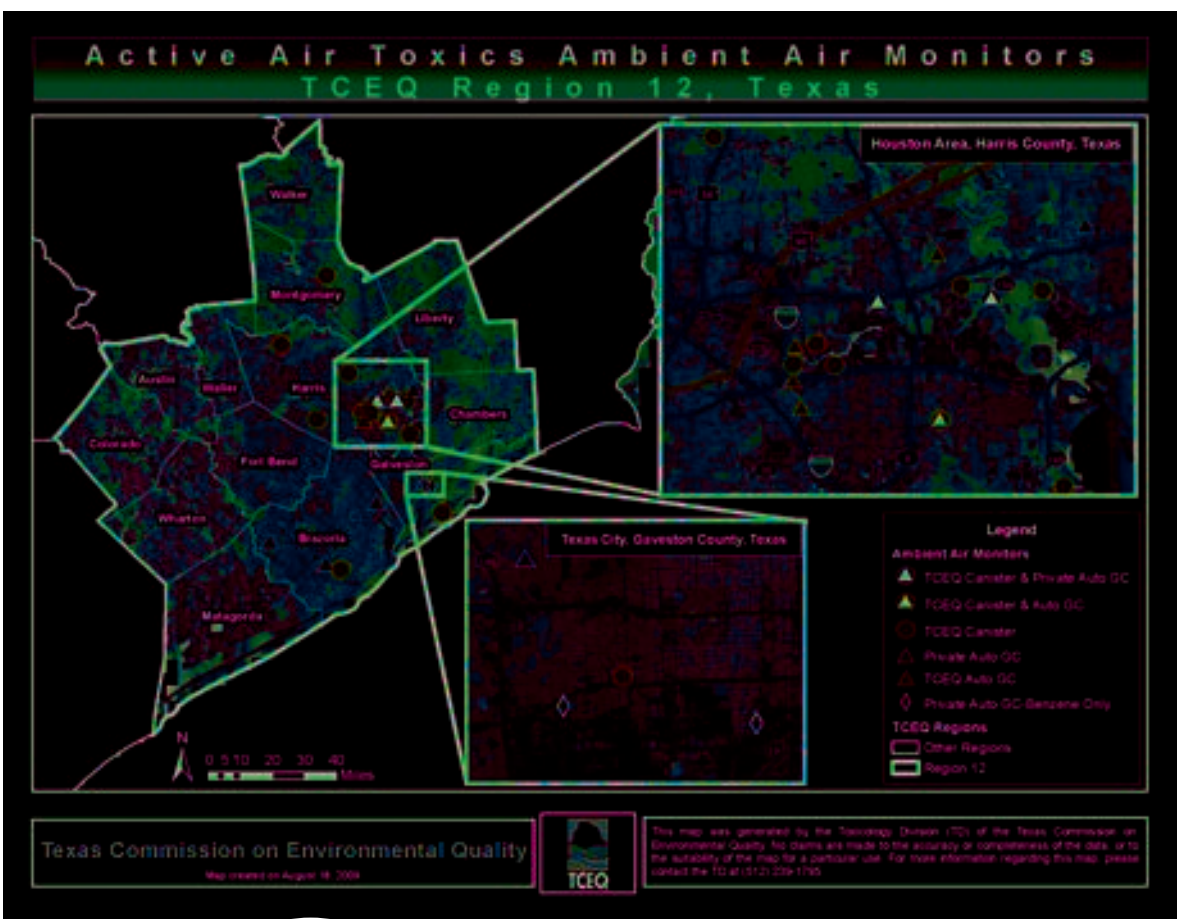
A map showing the various TCEQ Air Toxics monitoring sites is found in *Figure 1*.

Ozone/Smog

Smog is formed when nitrogen oxides and volatile organic compounds combine in the presence of direct sunlight, high temperatures and little or no wind.[vi] Houston's automobiles and industry emit these compounds into the air,[vii] making smog a serious concern. Ozone levels generally vary according to the season. Because sunlight, warmth, and light winds are necessary to create ozone, the summer months typically have higher levels of ozone.[viii] Smog can cause respiratory problems, aggravate existing lung conditions, and has been shown to pose risks for heart-related birth defects.[ix] It also can damage the ecosystem from the running trails of Memorial Park to the trees of Bayou Bend State Park.

Although this report will not discuss the topic in detail, air quality (and particularly ozone) is significantly influenced by weather. Air quality is determined by the combination of emissions, chemical processes in the atmosphere and reactions with surface materials, and physical transport by specific weather patterns.

Figure 1: *Houston Region Air Toxics*



By statute, the EPA is charged with determining ozone standards that do not harm human health or welfare.[x] The current NAAQS 8-hour standard for ozone is 84ppb. While Houston is struggling to conform to that standard, in 2008, EPA set a new standard of 75ppb. Additionally, a scientific committee that the EPA impanels to help set its standard has recommended that the agency lower the primary ozone standard even further, within the range of 60ppb to 70ppb.[xi] Indeed, the 2008 standard is formally under reconsideration by the EPA, and a stronger standard, in the range of 60 to 70ppb may be forthcoming. Following is an examination of how Houston is performing in its attempts to attain the 1997 standard, and how it might fare with the 75ppb level and a possible new level between 60ppb and 70ppb.

1990 Eight-Hour and One-Hour Ozone Standards

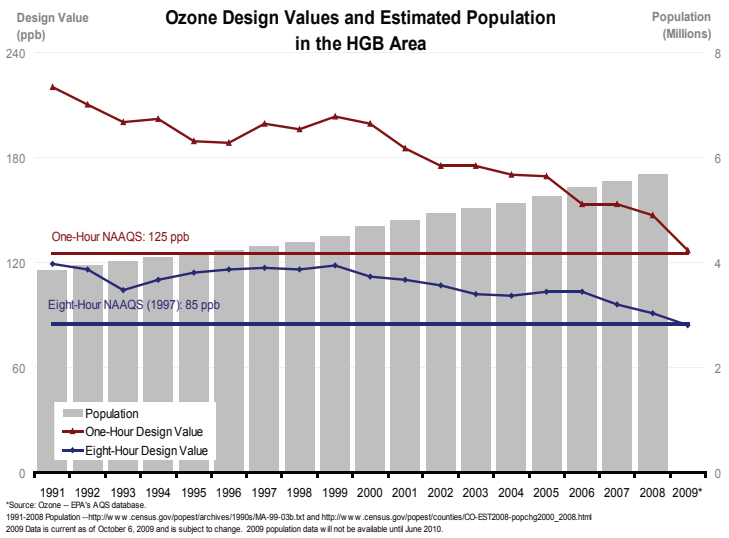
Eight-hour standards aside, Houston continues to fail in its pursuit of the 1990 ozone standard – the 1-hour 125ppb ozone standard. Houston was technically scheduled to meet this standard in 2007. Attainment is measured by averaging the 4th annual maximums during each of the last three years. However, the region failed the standard, and, for the first time, did not succeed in finding a technical maneuver to postpone a federal air pollution deadline.

Thus far, the region has been out of compliance for both 2008 and 2009. Many people in the Houston region have maintained that the 8-hour standard is a practical measure of ozone for the rest of the country. However, some believe that the Houston area should be held to the 1-hour standard because of the concentration of heavy industry that releases vast amounts of ozone precursors into the atmosphere on any given day. The 1-hour standard is a better benchmark for measuring and reducing these extremely harmful, but fleeting, industry produced ozone plumes, also known as eruptions.

While the Houston area has made progress in reducing the ozone concentrations in 2009, the region remains classified as a severe non-attainment area for the 1997 8-hour 84ppb standard. As a consequence of this classification, the EPA has set a deadline of June 15, 2019, for the Houston region to meet the standard.[xii] Extending the time to meet the ozone standard not only comes at a cost to area resident's health but also to the economy. As a consequence of being out of compliance with previous ozone standards, in 2009, a TCEQ fee program is expected to collect between $50 million and $150 million from area industry.

The growth of the region is a major complication to improving air quality. The graph below compares improvements in ozone to the region's increasing population growth. Since 1991, the population has risen steadily, while ozone design values have trended downwards.

Figure 2: *Houston - Galveston - Brazoria*

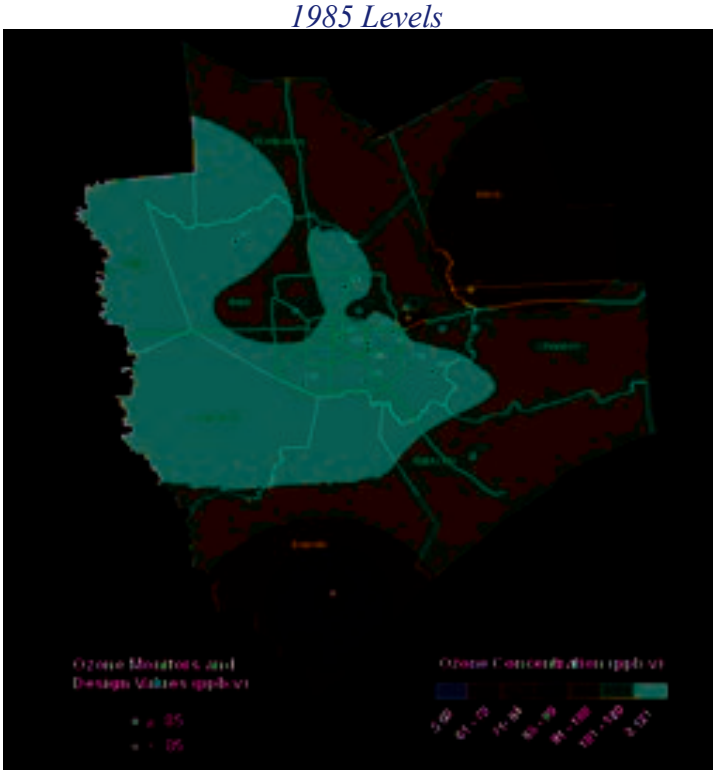


In 2009, several of Houston's regulatory ozone monitors have preliminary design values which comply with the 8-hour, 84ppb standard. This is a substantial achievement that reflects a significant expenditure of money and investment in technology by the region's heavy industry, favorable weather patterns, and reduced mobile- and point-source emissions due to the economic downturn. This improvement is also attributable to EPA's regulation through the Clean Air Act, enforcement by the TCEQ, vigilance and publicity brought to air quality issues by Mayor Bill White, and the turnover of the region's vehicle fleet.

The region undoubtedly continues to show improvement; this progress, in fact, can be seen in *Figure 3* as a long-term downward trend that illustrates the strides the region has made in reducing its smog pollution.

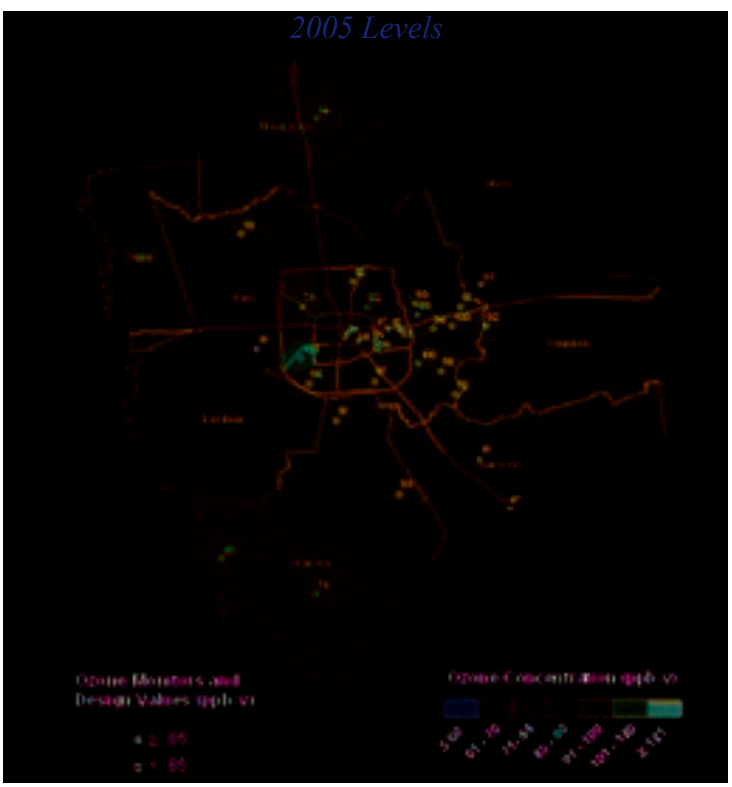
Figure 3
8-Hour Design Level of Ozone

1985 Levels



1995 Levels

2005 Levels



2008 Levels

Source: Houston Regional Monitoring

Soon, Houston and the rest of the country will be measured by the 75ppb level, a more rigorous standard. Viewed through this lens, the Houston region's ability to achieve this standard will present a serious challenge. Fewer than 10% of the monitors in the Houston region comply at this level. Additionally, as stated earlier, the EPA is considering an even lower level standard, possibly 65ppb. By way of example, it should be noted that none of the area's monitors would meet a standard of 65ppb. Assuming that the EPA continues its trend of increasingly stringent standards, Houston's air quality may not conform to the EPA's ozone standard for the foreseeable future.

Particulate Matter$_{2.5}$

Fine particulate matter pollutants are the result of fuel combustion, including emissions from ships, diesel trucks, motor vehicles, air planes, railroads, power generation, and industrial facilities. They are extremely small and generally cannot be seen with the naked eye. Their size makes them dangerous because the smaller the pollutant, the deeper it is likely to penetrate the lungs. Understandably, particulate matter pollutants aggravate asthma and other respiratory diseases, and contributes to lung cancer.[xiii] They also add to the haze and are harmful wildlife and wildlife habitat.[xiv]

The EPA's ambient air quality standard for fine particulate matter requires compliance with daily and annual emission requirements. The standard of most concern is the annual standard, currently set at 15 micrograms per cubic meter (µg/m3). To attain the annual average standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors, must not exceed 15.0µg/m3.

For some time, particulate matter monitors have hovered around the 15.0µg/m3, but since 2006 have exceeded the standard. As shown in Figure 4, Houston is in a monitored non-attainment status for $PM_{2.5}$. However, Houston has never been designated by the EPA as non-attainment.

Figure 4
$PM_{2.5}$ in the Houston-Galveston-Brazoria Region

Source: TCEQ Air Monitoring Data Base

The TCEQ and City of Houston operate three Federal Reference Method (FRM) sites for fine particulate matter, from which the data were derived for the graphic above. The three analyzers meet the EPA protocol for particulate monitoring and are used in determining attainment status. Data are collected in Harris, Galveston, and Montgomery counties. However, these are not the only particulate monitoring sites. Additional sites have Federally Equivalent Method (FEM) monitors used to measure continuous non-regulatory fine particulate. The history has been that co-located FRM and FEM monitoring record consistent data. The difference is the FRM monitors take a 24-hour composite sample while FEM non-regulatory monitors operate in a continuous mode that provides data for air quality index purposes, data analysis and modeling. The number and location of FEM non-regulatory continuous sites have varied over the years as the data needs have changed. Currently there are eleven $PM_{2.5}$ monitoring sites in the Houston-Galveston-Brazoria area, stretching from Conroe to Galveston.

Because Houston is just within compliance with the federal standard, fine particulate matter levels should be closely monitored. It should be noted that the scientific committee that advises the EPA on its national standard has recommended that the EPA strengthen the standard to 12.0-14.0µg/m3 range, which would make it more difficult for Houston to conform to EPA requirements.[xv]

Hazardous Air Pollutants

EPA and TCEQ contribute to the regulatory picture surrounding air toxics. EPA regulates hazardous air pollutants by requiring large polluters (i.e., point sources) that emit air toxics to employ the Maximum Achievable Control Technology (MACT) standard. The MACT standard requires the Maximum Reduction of Hazardous Air Pollutants, considering costs and other health and environmental effects.[xvi] In a site by site analysis, the EPA sets the MACT standard generally by identifying the lowest emitting technology of comparable sources and then requiring it at other facilities.[xvii]

TCEQ may add provisions to those regulated by the Clean Air Act in Texas. It addresses air toxics through "Effects Screening Level" (ESL) standards. The ESL is not a regulatory standard but an ambient air guideline. The TCEQ uses guidelines for a number of purposes, including identifying pollution hotspots.

Risk Level Guidelines used by TCEQ are derived from the Clean Air Act. A risk level of 1 in a million implies a likelihood that up to one person, out of one million equally exposed people would contract cancer if exposed continuously (24 hrs./day) to the specific concentration over 70 years (an assumed lifetime). This would be in addition to those cancer cases that would normally occur in an unexposed population of one million people.

The ESL guideline for the two toxic air pollutants discussed below encourages emitters to stay below the risk level of 1 in 100,000 cancer risk for long-term exposure. The 1 in 1,000,000 risk level is the most health protective of these guidelines and is advocated by environmental groups.

EPA has identified almost 200 hazardous air pollutants. Two air toxics that pose the most significant problems to the Houston region are benzene and 1,3-butadiene. In October 2009, the EPA announced that it would revisit rules applicable to refineries in response to requests from many interests, including those of former Mayor Bill White. While it may take some time for the EPA to resolve its course of action on this issue, it could result in more stringent regulations.

Benzene

Benzene emissions are the result of vehicular combustion and industrial processes.[xviii] The harm from benzene runs the spectrum. On one end, isolated short-term exposure may only result in dizziness and irritation to the respiratory system, eyes, and skin.[xix] On the other end, particularly where there is long-term chronic exposure, benzene might lead to blood disorders and deadly diseases like cancer.[xx]

The TCEQ risk level for exposure to benzene is 1.4 parts of contaminant per billion parts of vapor (ppbv) for a 1 cancer case in 100,000 people risk level. The risk level of benzene levels aspired to in federal regulations is 1 cancer case in 1,000,000 people, or .14ppbv, and the risk level for 1 cancer case in 10,000 is 14ppv.[xxi] The extent to which regional monitors approach or surpass these risk levels is illustrated in the graph on the next page.

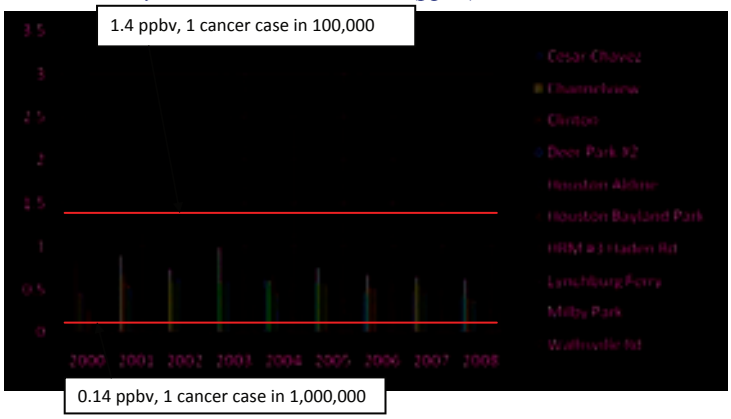
Monitoring using Automatic Gas Chromatography

There are two commonly used monitoring devices to measure benzene emissions. The first is a nearly continuous automated monitoring device known as Auto GC, an automatic gas chromatograph. The second requires taking samples in canisters and having them tested. To the extent that Auto GC samples are available, they are used exclusively, even if canister data is available. If only canister data is available, that data is reported.

Harris County

Harris County has the largest number of monitoring stations. The data suggests consistent progress in reducing benzene concentrations at most locations. For example, the Lynchburg Ferry site, historically known as one of the most problematic sites in the region, has shown substantial improvements. It should be mentioned, however, that like regional ozone levels, the impact of the 2008-2009 economic crisis and the subsequent reduction in chemical and petrochemical output have not been factored in as a contributor to the recent decline in emissions.

Figure 5
Harris County Annual Mean Benzene (ppbv) Auto GC Monitors



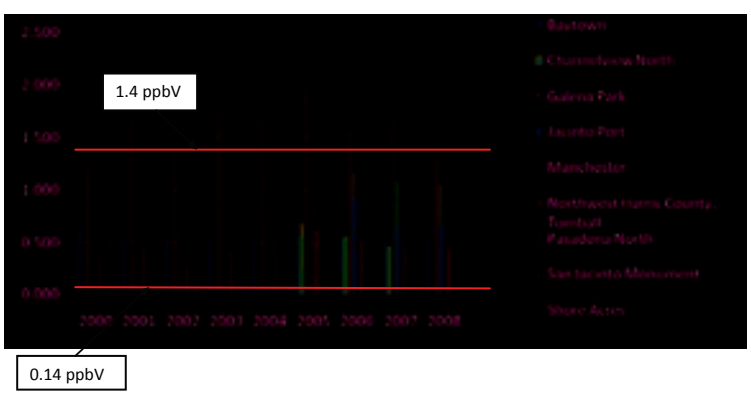
Source: TCEQ Toxicology Division

Monitoring using Canister Data

Those sites in Harris County that only have canister data indicate a downward trend. Galena Park has consistently been the worst performing of the sites monitored using canisters, yet it also has made progress. Both Lynchburg Ferry and Galena Park sites have seen shown decreases in benzene concentrations. The reductions have been more significant at Lynchburg Ferry which no longer has the highest benzene concentration in the area.

Data for Pasadena North in 2008 are shown in *Figure 6*. Pasadena North has quickly established itself as a site that warrants further monitoring because only three other sites in Harris County had higher benzene levels.

Figure 6
Harris County Annual Mean Benzene (ppbv) Canister Monitors

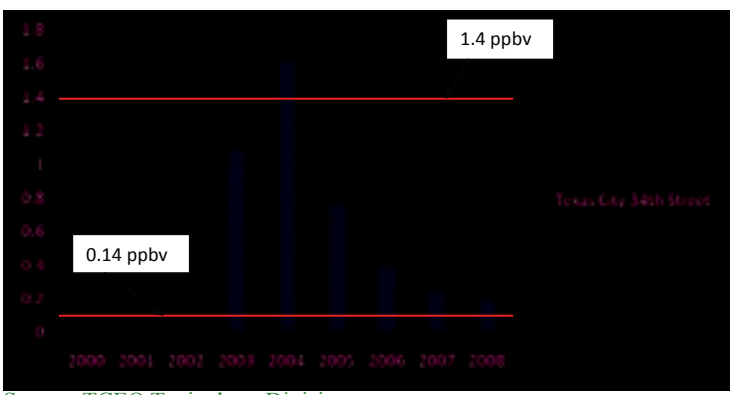


Source: TCEQ Toxicology Division

Galveston County

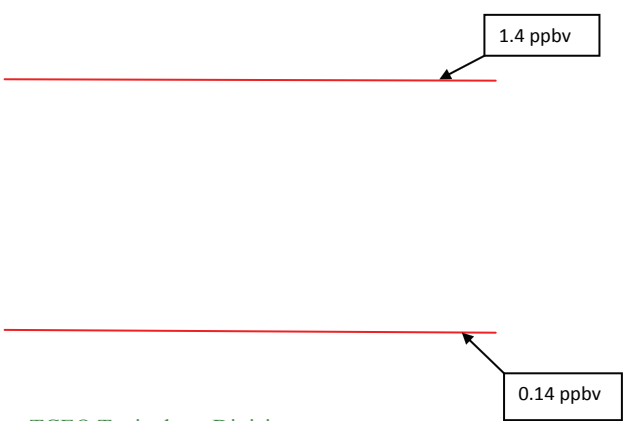
Outside Harris County, benzene levels at monitoring sites are lower. In Galveston County, the Texas City 34th Street Monitor has documented significant progress over the past few years. In 2004, the monitor registered over the 1 in 100,000 cancer risk level. In 2008, it dropped to almost the 1 in 1,000,000 cancer risk level. While most of these sites (both Auto GC and canister monitored sites) show improvement, it should be noted that in 2008, Texas City Ball Park benzene levels increased as compared to the previous year.

Figure 7
Galveston County Annual Mean Benzene (ppbv) Auto GC Monitors



Source: TCEQ Toxicology Division

Figure 8
Galveston County Annual Mean Benzene (ppbV) Canister Monitors

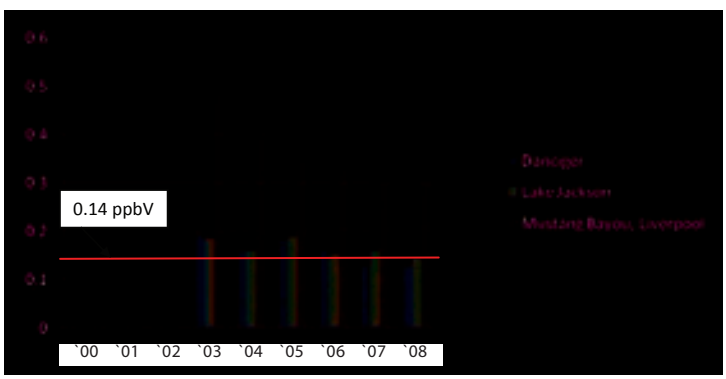


Source: TCEQ Toxicology Division

Brazoria County

Similarly, in Brazoria County, benzene emissions continue to drop to the 1 in 1,000,000 risk level for cancer. At the Mustang Bayou, Liverpool site, benzene levels have almost been cut in half during the past six years. According to canister data, there have been similar reductions at the Clute site.

Figure 9
Brazoria County Annual Mean Benzene (ppbv) Auto GC Monitors



Source: TCEQ Toxicology Division

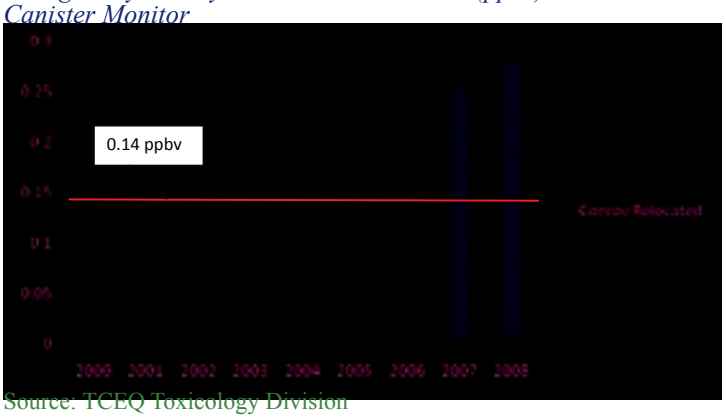
Figure 10
Brazoria County Annual Mean Benzene (ppbv) Canister Monitor

Source: TCEQ Toxicology Division

Montgomery County

There is a single monitoring site for benzene in Montgomery County. Since the data is recent it is premature to comment on a trend; however, benzene concentrations are well below the 1 in 100,000 risk level.

Figure 11
Montgomery County Annual Mean Benzene (ppbv) Canister Monitor



Source: TCEQ Toxicology Division

Butadiene

Butadiene is produced from burning fuels and can cause health problems, such as nausea, skin irritation, and fatigue. Children are especially at risk to develop leukemia. As with benzene, TCEQ tracks butadiene and its risk levels associated with cancer. In the 2007 *Counting on Quality of Life Indicator Report*, relying on data from the EPA and a Rice University study, the Center presented the risk levels for 1,3-butadiene as 1 case of cancer in 10,000 people at the 1.3ppbv level. At that time TCEQ advocated 1 case of cancer in 100,000 at the 0.13ppbv level, and 1 case in 1,000,000 at the .013ppbv level.

Since the 2007 Indicator Report, TCEQ has instituted a number of policy changes, including new ESLs. This report contains an updated long-term ESL of 9.1ppbv for 1,3-butadiene, which is used for TCEQ air monitoring. TCEQ states that both the methodology for developing the 1,3-butadiene ESL, and the 1,3-butadiene ESL itself, have undergone external scientific peer review by world-renowned experts. The experts' conclusion was that the risk level of 9.1ppbv is scientifically defensible and health protective. This change in policy, which occurred in 2008, is significant, in that for long-term ESL of 9.1ppbv for 1,3-butadiene, monitored concentrations are well below a level that would be expected to cause adverse health effects. None of the monitoring data indicate a health concern.

For each air toxic, there may be several ESLs used for different purposes. For 1,3-butadiene, a separate, more stringent ESL exists for air permitting. The ESL used for air toxics permitting is 4.5ppbv, more stringent because TCEQ evaluates cumulative risk at the permitting stage.

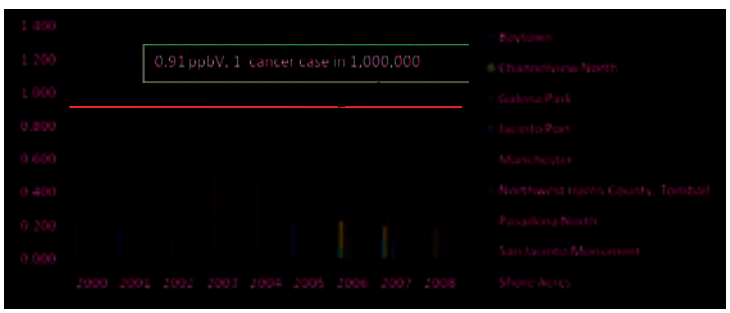
Harris County

As of 2009, Milby Park is the one site that close is to exceeding the 1 in 1,000,000 risk level or .91ppbv. In 2005 and 2006, the risk at the Milby Park site exceeded this risk level. It has dropped since then, but it is still a concern.

Figure 12
Harris County Annual Mean 1,3-Butadiene (ppbv)
Auto GC Monitor

Source: TCEQ Toxicology Division

Figure 13
Harris County Annual Mean 1,3-Butadiene (ppbv)
Canister Monitors



Source: TCEQ Toxicology Division

Galveston County

The progress at the Texas City 34th Street site is particularly noteworthy.

Figure 14
Galveston County Annual Mean 1,3-Butadiene (ppbv)
Auto GC Monitors

Source: TCEQ Toxicology Division

In the remainder of Galveston County, while current data does not indicate a health concern, the slight rise in 1,3-butadiene levels since 2006 warrants careful future monitoring.

Figure 15
Galveston County Annual Mean 1,3-Butadiene (ppbv)
Canister Monitors

Source: TCEQ Toxicology Division

Brazoria County

There have been reductions in 1,3-butadiene levels among the monitoring sites in Brazoria County. Mustang Bayou, Liverpool and Clute have historically and still remain the sites of most concern.

Figure 16
Brazoria County Annual Mean 1,3-Butadiene (ppbv)
Auto GC Monitors

Source: TCEQ Toxicology Division

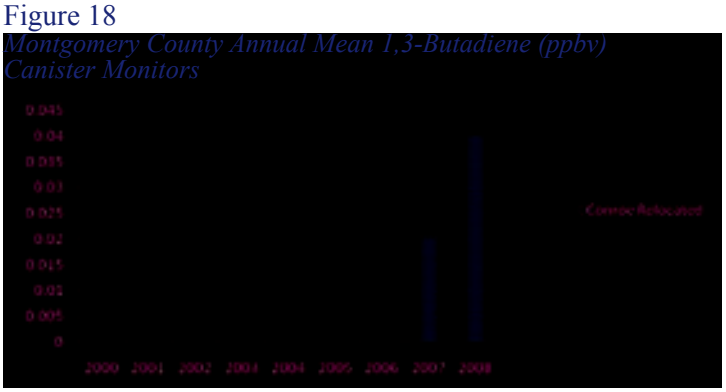
Figure 17
Brazoria County Annual Mean 1,3-Butadiene (ppbv)
Canister Monitors

Source: TCEQ Toxicology Division

Montgomery County

The Conroe Relocated Site is the only monitoring site in Montgomery County, and only two years of canister data is available. While 1,3-butadiene levels are well below the 1 in 1,000,000 cancer risk level, it is noteworthy that from 2007 to 2008, butadiene concentrations have nearly doubled. Given this upward trend and the population and traffic growth, the site warrants close monitoring.

Figure 18
Montgomery County Annual Mean 1,3-Butadiene (ppbv)
Canister Monitors



Source: TCEQ Toxicology Division

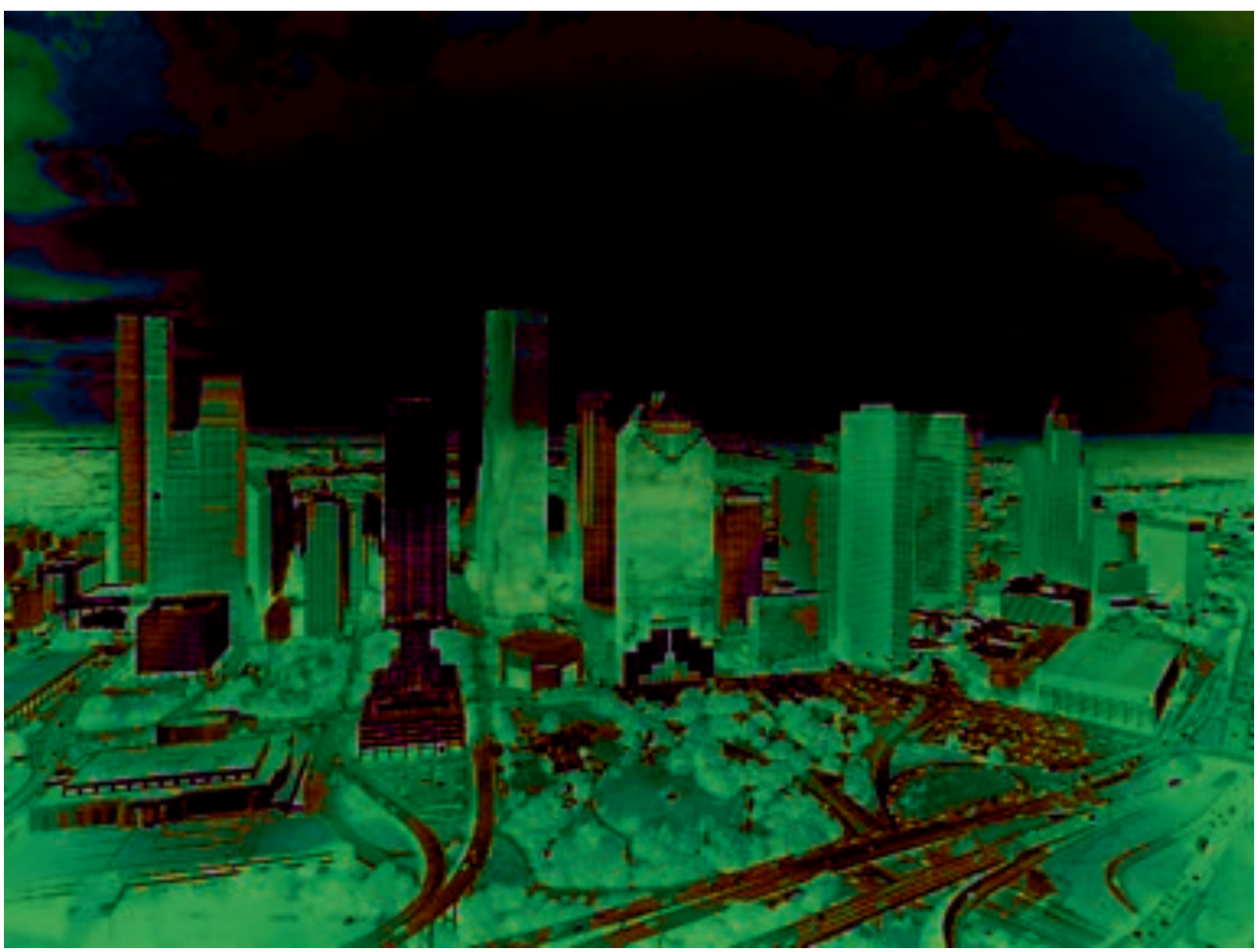
Where do we go from here?

Significant improvements in air quality have been made in the last twenty years, due in part to TCEQ regulations and the substantial impact of the federal Clean Air Act. In addition, voluntary efforts by industry, others in the regulated community and the leadership shown by former Mayor Bill White have spurred progress. According to TCEQ Ambient Monitoring Data, the highly reactive, and nitrogen oxides (NOx) have decreased by 50% and 30% respectively from 2003 to 2008. This decline in the ozone precursors has resulted in a decrease in the number of days and hours that the region exceeds the ozone standard.

Our region also has many voluntary strategies to reduce mobile source emissions. (*Appendix A*) In the future more of these programs will be needed. In addition, planned mass transit projects, including commuter and light rail, will be an enormous help by reducing congestion and, as a consequence, improving air quality.

There is still room for improvement. As EPA tightens ozone, fine particulate and other pollutant standards, or as new compounds are added, Houston will face unique challenges in improving air quality. Unlike many other metropolitan areas, the region faces a growing population; increasing vehicular traffic, already more than 120 million vehicular miles per day; and, one of the largest petrochemical and refining complexes in the world. However, without this industry, the region would not be experiencing jobs and growth that will lead to sustainability in the 21st Century. The challenge is how to reach consensus. What new technologies will be needed? What trade-offs should be made that reasonably balance the region's economic health and the physical health of its citizens?

The data show how Houston area leaders have worked together to reduce levels of air pollutants. The citizenry of the greater Houston region, its business leadership and its elected officials must remain vigilant, involved, committed and work together to continue the improvements in the region's air. Real improvement is critical if our region is to build and maintain a quality of place that is a magnet for enterprising, creative and energetic people for decades to come.



Downtown Houston Skyline

CHAPTER 2: PARKS & TRAILS

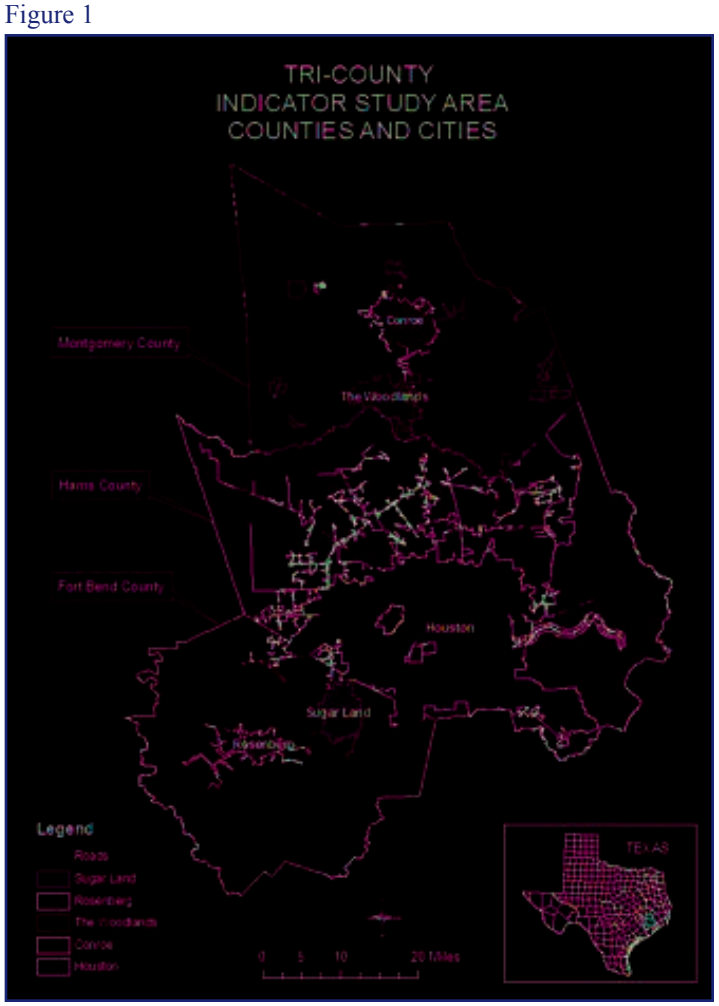
Author: Ty Ann Noyes, GIS Analyst
Lone Star College - North Harris GIS Adjunct Professor

Executive Summary

An extraordinarily important indicator of quality of place is the amount and location of Parks & Trails. They provide the visual and mental relief from a developed landscape that, in this region, is associated with vast freeways, street grids, housing development, high rises, commercial spaces and generally unattractive strip centers. Moreover, when parks and greenspaces are readily accessible to area residents, they contribute mightily to their health and well-being and the land on which they reside.

Figure 1 illustrates the counties and cities that are included in the 2009 study.[ii]

Figure 1



The purpose of this chapter is to measure how the region is progressing in terms of providing Parks & Trails for its residents. To do so, two national standards, 20 acres/1,000 residents and percent of population within one-fourth mile of a park or trail, were adopted and used in the 2007 report. They are used in this report as well. The 2001 Harris County Master Plan adopted a goal of 20 acres/1,000 residents. It should be noted that Harris County is currently re-evaluating this standard.

The 2009 Indicator Study examines the community goals, the amount of park space and the accessibility to parks of three counties, including Ft. Bend, Harris and Montgomery Counties, and several communities within each. These counties and the cities therein were chosen because they are experiencing significant population increases and are of growing importance in the regional economy and quality of place.

Assuming a goal of meeting national standards set by professional park associations, and to the extent that data were available, comparisons between the 2007 and the 2009 Center studies shows virtually no change. Relatively little land was added to the park inventory from 2006 to 2008; yet, these counties and cities are projected to be among the fastest growing areas in the country during the coming decade. The Parks & Trails challenge becomes: how will the greater Houston region provide the amount of park space necessary to meet the public good and create sustainable environment in which people will want to live, work and play? How will the region get ahead of anticipated growth with respect to Parks & Trails?

Table 1 summarizes the progress in providing park space to area residents by the three counties and selected cities that were studied.

Table 1

National Standard	Acres/1,000 residents 20 acres/1,000 residents		Accepted Walking Distance % Population in 1/4th Mile	
	2006	2008	2006	2008
Ft. Bend County	NA	14.23	NA	35
Rosenberg	NA	6.53	NA	22
Sugar Land	NA	13.1		56
Harris County	13.5	14.05	30	30
Houston	15.82	15.39	41	NA
Montgomery County	NA	4.35	NA	24
Conroe	NA	NA	NA	31
The Woodlands	NA	NA	NA	91

Why Are Parks & Trails an Important Component of Quality of Place?

Public parks, trails, and open spaces are a vital component of a community's infrastructure as well as being essential to the health and wellness of its citizens.

Increased Social Capital

Parks enhance the quality of place for individuals by providing a space where neighbors come together, strengthening community cohesiveness and social capital. Family values are reinforced and support systems are nurtured as people of all ages can enjoy time socializing and playing. Parks offer an opportunity for everyone to participate in recreation, leisure, physical, and educational activities. These activities are important in promoting physical, emotional, and cultural well-being.

Improved Health

The importance of parks and trails for community health cannot be understated. For people who use parks and recreational facilities the benefits are well-known and widely accepted, including reduced heart disease, diabetic conditions and obesity. Texas is among the leaders in the country for obesity rates in the population.

Improved Air & Water Quality

Parklands promote the health of the natural environment as well. Parks provide permeable surface areas that collect precipitation which in turn recharge the groundwater and slow runoff. According to the Houston Parks Board, one acre of grassland absorbs 27,000 gallons from one inch of rain. This is helpful in managing flood waters. Trees, grass, and other vegetation in parks filter water runoff, helping to keep the bayous, rivers, streams, and bays clean.

Vegetation improves air quality by removing air pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and particulates.

Moreover, tree canopy is a key factor in reducing urban heat island effect, a significant issue in the area. The health of the natural environment impacts the quality of place for the entire community. According to the Houston Parks Board, one acre of parkland absorbs 2.6 tons of carbon per year, which is 26,000 miles in an average car.

Contribution to Economic Development & Prosperity

Additionally, parklands contribute in a real way to the economic health of a community. The Trust for Public Land, a nonprofit, land conservation organization, reviews methodologies that provide quantifiable evidence substantiating the economic value of city parks systems. Seven attributes of city parks, including property values, tourism, direct use, citizen health, community cohesion, clean water, and clean air, provide measureable economic value, such as increased property value, tax base, and tourism revenue.[i] According to the Houston Parks Board, the existence of parks helps to increase residential property values by 5% to 22%, and may increase commercial property values up to 74%.

What Are the Communities' Goals?

Not all counties or cities have Park Master Plans but most governmental entities contain ordinances and official statements outlining the importance of parks to residents of their jurisdiction. As outlined in their Park Master plans, each county is distinct and unique with respect to size, population, government, and approach to developing park programs. But, all share in the desire to provide quality parklands, open spaces, and trail systems in order to enhance the quality of place for their residents and improve business opportunities. Many parks departments included in this study recognize the critical importance of obtaining the involvement and coordination with neighboring governments, local community organizations and businesses, as well as individual citizens, in the development of both the master plan and the implementation of a successful park system.

Fort Bend County

Ft. Bend County has the largest number of master planned communities of any county in the nation. The Parks and Recreation Department of Ft. Bend County was established in 1995 and is responsible for development and maintenance of five active parks, three leased parks, and four community centers. Ft. Bend County and regional residents benefit enormously, including economically due to tourism, from having Brazos Bend State Park, more than 5,000 acres managed by the State of Texas, only 28 miles from downtown Houston.

The Fort Bend County Parks, Recreation, & Open Space Master Plan, 2007-2012 goals focus on the following opportunities:

Regional Parks – The County encourages partnership with city park departments and neighborhood associations to provide neighborhood parks and mini-parks.

Community Centers – The County provides Community Centers in unincorporated areas by working with multiple partners and stakeholders to manage and provide services.

Transportation Corridors – The County collaborates with city parks departments to coordinate efforts on linear park systems such as the Brazos River Corridor.

"The County's preferred model calls for the cities and new residential developments to offer neighborhood, community, and large urban parks, with the County driving the creation of regional parks; and developing of transportation corridors, and regional trail connectivity; and leveraging relationships with State and Federal agencies to ensure the County is serving regional needs, while also ensuring that under-served neighborhoods in unincorporated areas are not neglected."[iii]

Table 2 is a summary of park acreage in Ft. Bend County. Parkland by precinct was unavailable.

Table 2: *Park Acreage Within Fort Bend County*

Fort Bend County	2008
Fort Bend County Parks	766
State & City Owned	6,805.6
Total Acreage	7,571.6
Fort Bend County Population	532,141
Acres per 1000 residents	14.23

Brazos Bend, at 5000 acres, is the only state park.
City owned parks = 1,805.6 acres
~2008 U.S. Census Estimate

This indicator study examines the park systems in the cities of Sugar Land and Rosenberg, two growing communities within Fort Bend County.

Sugar Land

Sugar Land was founded in 1910 as a company town, only bocoming a municipality 50 years ago. It is the largest city in Fort Bend County with 14 neighborhood, mostly active, parks and eight community parks, that offer a range of outdoor activity, including ball fields, swimming pools, and mountain biking. The City benefits from being situated along the Brazos River and has acquired 1200 acres and hopes to own almost 3600 acres for parks, open space and conservation along the river's corridor.

The City has adopted the following goals:

1. Plan a connected system of routes for pedestrians and bicyclists for exercise, recreation and mobility.
2. Focus on linking portions of the City together as well as connecting neighborhoods to parks, schools, libraries, shopping areas and other areas of interest. Connection opportunities to adjacent cities such as Missouri City and the Houston Extra-territorial Jurisdiction (ETJ) are noted as key links to broaden the network.
3. Implement, in phases, over 150 miles of on- and off-street trails and sidewalks.[iv]

A major goal is to provide a park system that meets the total recreation and leisure needs of the community. They seek to identify, protect, and preserve open spaces and critical natural areas.[iv] *Table 3* summarizes park acreage in Sugar Land.

Table 3: *Acreage*

Sugar Land	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total acreage	**738.1**	**847.1**	**847.1**	**896.1**	**896.1**	**896.1**	**941.6**	**944.0**	**944.0**
***Sugar Land Population**	64850	66484	69242	71522	74279	76207	78681	79276	80704
Acres per 1,000 residents	11.38	12.74	12.23	12.53	12.06	11.76	11.97	11.91	11.70
***2008 U.S. Census Population**									

Rosenberg

An historic town, Rosenberg was settled around 1823 by Stephen F. Austin's Old Three Hundred. Still a small city, the overall goal for Rosenberg is to maintain and improve its existing parks, provide a balanced and wide variety of parks and recreation opportunities that are conveniently accessible to all persons throughout the City and the ETJ. The city seeks to provide ongoing and continuous management and coordination to sustain a "first-class" park system.[v]

Rosenberg has seven active parks and one Nature Park which covers 164 acres along Seabourne Creek. *Table 4* is a summary of park acreage in Rosenberg.

Table 4

Rosenberg Park Acreage	2008
Total Park acreage	219.4
Rosenburg Population	33595
Acres per 1000 residents	14.23

* Park Acreage within city limits.
~ 2008 U.S. Census Estimate

Table 5 shows the park land that is available to residents of Harris County. This report calculates total park acreage available to Harris County (HC) residents by precinct (PCT) aggregating park acres within the county limits no matter which park agency operates those parks acres. These acres are then divided by the number of county residents.

Harris County

Harris County, the most populated county in Texas and the third most populated county in the United States, contains over 30 municipalities including most of the City of Houston.[vi]

The Harris County Master Plan for Parks, Recreation and Open Space sets a general goal of maintaining a ratio of 20 acres of park space for every 1,000 residents. The Master Plan developed in 2001 set a goal of having 68,767 park acres in 2005 to meet its goal. Today, Harris County has almost 56,000 acres, a shortfall of more than 11,750 acres. In 2008, Harris County contained 14.05 acres per 1,000 residents, a shortfall of almost 6 acres per resident.

Table 6: *Miles of Greenway Trails in Harris County*

	2006	2008
Harris County	439.1	NA
City of Houston	341	NA
Total	780.1	NA

The Harris County park system is divided into four Commissioner Precincts. To meet the particular needs of the County, these four precincts are responsible for the development and management of individual county parks within their area. Therefore, separate analysis was performed for park data by precinct. A set of county goals and objectives were developed for Phase Two of the Master Plan for Parks, Recreation and Open Space based on the needs and resources of the county. These goals are outlined on the following page.

Table 5: *Park Acreage Available to Residents*

Harris County	2003	2006	2007	2008
COH Parks & Recreation Dept.	21,944*	22,195.40	22,227.59	22,239.57
HC PCT 1	2,233.47	2,439.0		2,735.0
HC PCT 2	3,806.55	3,880.0		3,899.2
HC PCT 3	11,458.55	13,565.0		13,637.2
HC PCT 4	3,581.98	3,708.2		3,708.20
State owned parks	4,156.0	4,156.0		4,156.0
Ft. Bend parks in Harris County (HC)	2,023.0	2,023.0		2,023.0
SPARK Parks/all districts within HC	480.0	540.0	700	750
Other municipal parks in HC	2,827.0	2,827.0		2,827.0
Total park acreage in 2008 = 55,975.17				
Harris County Population	3,393,321	3,886,207		3,984,349
Acres per 1000 residents	13.83	13.50		14.05
2003-2008 Increase in Acreage				5,541.57

*City of Houston Parks Dept. includes 2,518 acres of Lake Houston (Land) Park Acreage within HC
Estimate, Kathleen Ownby, Spark Parks, City of Houston
~2008 U.S. Census Population

- *General Goal*

Develop and enhance a balanced network of parks and facilities to serve the passive and active needs of the citizens of Harris County. The park system should be developed in a fiscally responsible manner and should not duplicate or compete with parks and recreation facilities of the incorporated municipalities or recreational facilities developed by the private sector.

- *Active Recreation Goals*

Acquire new or develop existing parkland for sports complexes to accommodate current and future needs of the residents of Harris County. Consolidate organized sports activities into larger complexes for more efficient management and maintenance and utilize smaller parks with limited fields as practice facilities.

- *Passive Recreation Goals*

Develop passive recreation within existing facilities, through acquisition of new land or through inter-local agreements with municipalities or organizations such as the Harris County Flood Control District.

- *Open Space and Natural Environments Goals*

Continue to identify, protect and preserve quality natural open spaces for unstructured recreational activities, inherent aesthetic value and protection of valuable ecosystems.

Houston

Houston, the fourth largest city in the United States, lies mostly within Harris County but extends into Fort Bend and Montgomery counties. Created in 1916, the City of Houston Parks Department manages, maintains and stewards 350 developed parks and more than 200 greenspaces and esplanades. Esplanades are not counted as park space in this study.

Houston's Parks and Recreation 2007 Master Plan Update expresses the desire to meet the demands of an ever-growing population with its diverse needs. Seven key concepts have been identified to reach the long-range goals. They are summarized as follows:

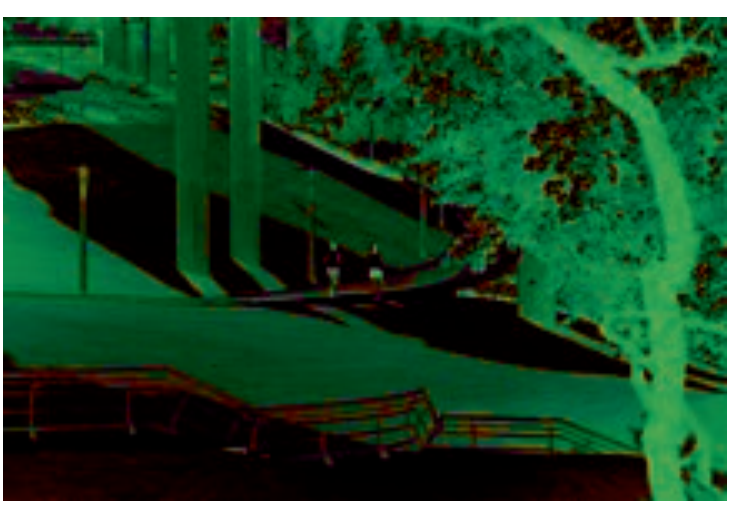
- Create equity and balance in the system
- Create connections by developing trails
- Demonstrate environmental leadership
- Improve recreation programming by addressing needs of the users
- Add signature parks to the system
- Improve active sports facilities
- Establish a regional green space and recreation approach[vii]

Table 7: *Acreage Purchased, 2003 - 2008*

City of Houston	2003	2004	2005	2006	2007	2008	Totals
Parks Dept	71.04	175.1	96.81	4,793.57	**32.19**	11.98	5,180.68
Houston Parks Board	13.4	148.15	0.77	422.39	33.20	8.5	626.41
Discovery Green		12.0					12.0
Total							**5,819.09**

It is important to note that of the 5,819 total acres purchased by the City of Houston, 10% is located in one park – Lake Houston Wilderness Park which is approximately 30 minutes north of downtown Houston, near the city of New Caney, TX. Prior to the City's acquisition of Lake Houston, it was operated as a park by the State. Also note that fewer acres were added to the City of Houston park space in 2008 than in previous years.

Table 5 shows the park land that is available to residents of Harris County. This report calculates total park acreage available to Harris County (HC) residents by precinct (PC) aggregating park acres within the county limits no matter which park agency operates those parks acres. These acres are then divided by the number of county residents.



Buffalo Bayou Park

Table 8 shows the parkland that is available to residents of the City of Houston. This report calculates total park acreage available to City of Houston residents by aggregating park acres within city limits no matter which agency operates those parks. The total acres are divided by the number of city residents.

Table 8: *Park Acreage Available to City of Houston Residents*

Harris County Parks Within COH Limits	2006	2007	2008
COH Parks & Recreation Dept. within City Limits	19,353.40	19,385.59	19,461.94
HC PCT 1	95		391
HC PCT 2	39		58.2
HC PCT 3	11,406.30		11,478.5
HC PCT 4	75		75
State*	380		380
Ft. Bend**	2,023		2,023
SPARK***	550		650
Total Park Acreage in 2006 = 33,921.70			
Total Park Acreage in 2008 = 34,517.64			
Houston Population	2,144,491		2,242,193
Acres per 1000 residents	15.8		15.39

*State Parks and Wildlife within city limits
**Fort Bend County Park Acreage Within City of Houston
***SPARK Parks/Houston ISD & Other
Estimate from Kathleen Ownby
~ 2008 U.S. Census Population

Montgomery County

Montgomery County is a fast growing community dedicated to providing quality park facilities for its residents and visitors. Cities and community agencies work closely with the Montgomery County Parks Department which supervises park projects. Currently, Montgomery County has no Master Plan; however, the Montgomery County Parks Director and Precinct 3 are currently involved in a discovery process that will be useful as they develop a Master Plan. Once this is developed, there will be goals by which to measure progress within Montgomery County.

Table 9 is a summary of park acreage in Montgomery County and its four precincts.

Table 9: *Montgomery County*

	2008
PCT 1	349.95
PCT 2	163.86
PCT 3	1,188
PCT 4	168.4
Park Acreage	1,870.21
State & City Acreage	0
Montgomery County Population	429953
Acres per 1000 residents	4.35

~2008 US Census Population

Conroe

According to the City of Conroe's website, the city has 23 parks totaling almost 340 acres. Park sizes range from a park of 201 acres to one acre 'pocket' parks. Many parks were developed in conjunction with civic organizations, local businesses and the Conroe Independent School District. Almost all Conroe parks are active parks with recreation equipment, ball fields, etc. The Conroe Parks Department is in the process of transferring park data to a GIS format and when complete more specific information will be available.

The Woodlands

The Woodlands Community Association is a master planned community, located primarily in Montgomery County, but extending into Harris County. From its inception and as an integral part of its development plan, The Woodlands was designed to include recreational opportunities such as pathways, swimming pools, sports fields, and open space or greenbelt reserves. The goal of The Woodlands "hometown" as stated in their Executive Summary is:

"To preserve, maintain and improve the quality of life in The Woodlands through the provision of quality recreational opportunities and programs, through the protection of the natural environment, and through stewardship of existing open spaces, parks, facilities, pathways, roadsides and medians."

Table 10 summarizes the acreage of greenway trails within Montgomery County.

Table 10: *Miles of Greenway Trails in Montgomery County*

Miles of Greenway Trails	2000	2001	2002	2003	2004	2005	2006	2007	2008
Montgomery County Trails	1.5	2.4	2.4	3.7	3.7	4.2	4.2	4.7	4.7
Trails in The Woodlands									100

Municipal Utility Districts

Approximately three years ago, local Municipal Utility Districts (MUD) began issuing park bonds as a means of developing parks and open space in new developments. The park bond is an important tool for obtaining and financing parks when new housing and commercial development occur. The fact that developers and MUD boards are willing to set aside land for parks is laudable and illustrates the importance of quality of place and Parks & Trails to attract homeowners and investors.

Data on MUD expenditures and acreage for park space is very difficult to obtain as there is no central reporting system. However, the Center did receive partial data from a Municipal Information Services Company. Since MUDs began issuing park bonds, and as of August 20, 2009, $461.4 million in parks bonds have been authorized in the Houston Extraterritorial Jurisdiction; however as of the same date, only $9.4 million parks bonds have been issued.

How Can Progress Be Measured?

City and county records provide statistical data from which to measure an agency's acquisition of public park land and its progress toward reaching its expansion goals. It is important that a set of criteria be established which defines the attributes being measured. For the purpose of this report, "park" refers to every kind of public park within the municipal boundary of the city, including state, county, regional, and municipal parks. Not included are parks in gated communities, or private parks owned by homeowners associations, private golf, tennis, swimming or other clubs. "City" is defined as the actual city boundary; it does not include the extra territorial jurisdiction (ETJ).

Due to the variances in how a community defines or measures parks, some inconsistencies may exist in this study. Harris County does not attempt to measure publicly owned open space, but only parks. This may not always be the case with other counties or cities.

Applying Standards

There are a variety of measurements and standards used to evaluate a community's effectiveness in meeting the citizen's needs for parks and recreation services. The Recreation, Park and Open Space Standards and Guidelines, published by the National Recreation and Park Association (NRPA) provide park space standards widely adopted by cities across the country. NRPA recommends a park range from 11 to 20 acres per thousand residents.

Using the NRPA standards to measure acreage per capita is a helpful tool in evaluating progress within a community. However, the primary standards must be those developed here in the Houston region, with careful consideration of our own community resources. When acreage per capita is used to make comparisons between communities, care must be taken to define the criteria used for the park land being studied or the results can be misleading. For example, The Trust for Public Land (TPL) allows cities to include lake or water acreage within or adjacent to the public parks. This study does not. Lake Houston Park includes approximately 12,000 acres of water surface and 4,816 acres of land; 605 acres are within the city of Houston. The water acres certainly are recreational assets but are not currently managed as such and, due to the Lake's size are best considered separately.

The data used to calculate the number of acres of land dedicated for parks and recreational use, per unit of population, were provided by the individual city or county agency. Not all data has been updated; for example, municipalities have not been updated by Harris County since 2003, and therefore the findings may be understated.

The population statistics for 2003, 2006, and 2008 population statistics were projected from the U.S. Census Bureau.[viii] To determine the ratio of acres of land per 1,000 population two criteria were considered:

1. City (or County) park acreage as a stand-alone value, i.e. just city parks or just county parks serving the residence of the region, and

2. All city (or all county) park acreage, i.e. all public park acres within the city's or county's boundaries. This was done to accommodate the two data submission methods from the different counties and cities. The chart below is a summary of the information collected from some of the cities included in the tri-county regional report.

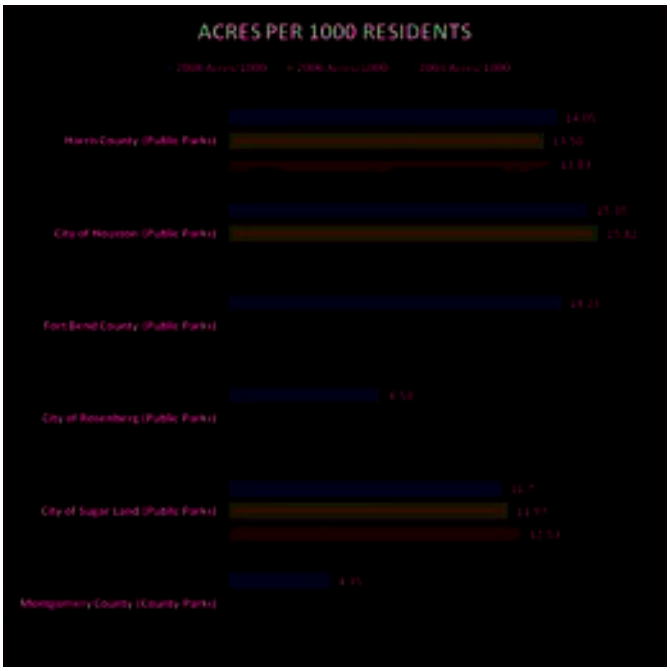
What Is the Current Status?

When using all public parks within a given city or county to evaluate available park acres per 1,000 residence, Fort Bend County, Harris County, the Cities of Houston and Sugar Land led the tri-county area with ratios of acres per 1,000 residents. The city of Houston has 15.39 acres per 1,000 residents; Harris County has 14.05 acres per 1,000 residents. Fort Bend County has 14.23 acres per 1,000 residents, and Sugar Land has 11.7 acres per 1,000 residents. These findings were based on the information supplied by each agency. *Figure 2* illustrate acres per 1,000 resident for the study area.

Access to Parks and Trails

National standards that rank or evaluate the total size of a park system by calculating park acres per person may not meet the needs of all communities equally, or may be misleading. This method of evaluation does not address an important fact that available access or fair distribution of park land greatly impacts the effectiveness of the park system.

Figure 2



To quantify the progress being made toward providing access to parks, a second method of measurement was applied in which the number of residents within a quarter of a mile radius of a park or trail was calculated. A quarter of a mile is the distance generally accepted by park experts as the one that most people will walk to get to a park. This was achieved through the use of Geographic Information System (GIS) analysis. The quarter mile buffer method of analysis was also used in the 2007 *Center for Houston's Future: Counting on Quality of Life Indicator Report* and establishes a baseline for past and future comparative studies. The accuracy of these results is dependent upon the accuracy of the data provided for the previous study.

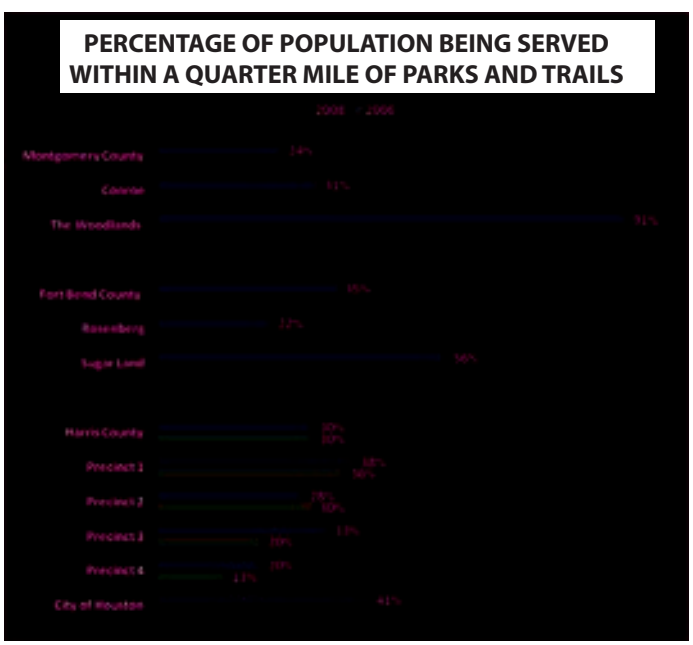
This phase of the study used GIS shapefiles provided by the individual county and city. Since each agency has its own standard and procedure for acquiring GIS data, there may be some inconsistency in what is measured as "park" land. While this report recognizes these inconsistencies, the findings do offer a general overview of progress being made toward the fair distribution of park and recreational land. All city, county, and state municipal parks for which GIS data was submitted were included for this analysis, regardless of park size. The analysis does not represent all available public parks. For example, data for the Harris County municipalities has not been updated since 2003, so the actual park acreage is undercounted.

In addition to public parks, greenway trails were included in this measurement. Greenway trails are off-road paths that can be part of a park, reservoir, MUDs, flood control land, or wetland. Trails include those along bayou corridors or other non-street rights of way. They benefit the community in terms of accessibility of park space to citizens outside the quarter mile buffer, as well as increase citizen mobility and habitat connectivity. Greenway or off-street trails create land and waterway linkages and take advantage of land that is not suitable for residential or business development. Trail data was supplied from a number of public and private sources. Much of the trail system data was verified in 2007 by Peter Price and GIS students at Lone Star College.

Planned communities like The Woodlands provide a unique opportunity for residents, as developers plan and design neighborhoods with access to parks, recreational, and trail facilities. The Woodlands reports over 100 miles of trails within their boundary. This is one of the contributing factors to its success in providing a quarter mile service that is reaching 91% of their residents.

Projected 2009 population data derived from the ESRI 2000 Census Block Data was used to calculate the percentage of an area's population living within a quarter mile of a park or trail facility. The results of these GIS calculations can be seen in *Figure 3*.

Figure 3

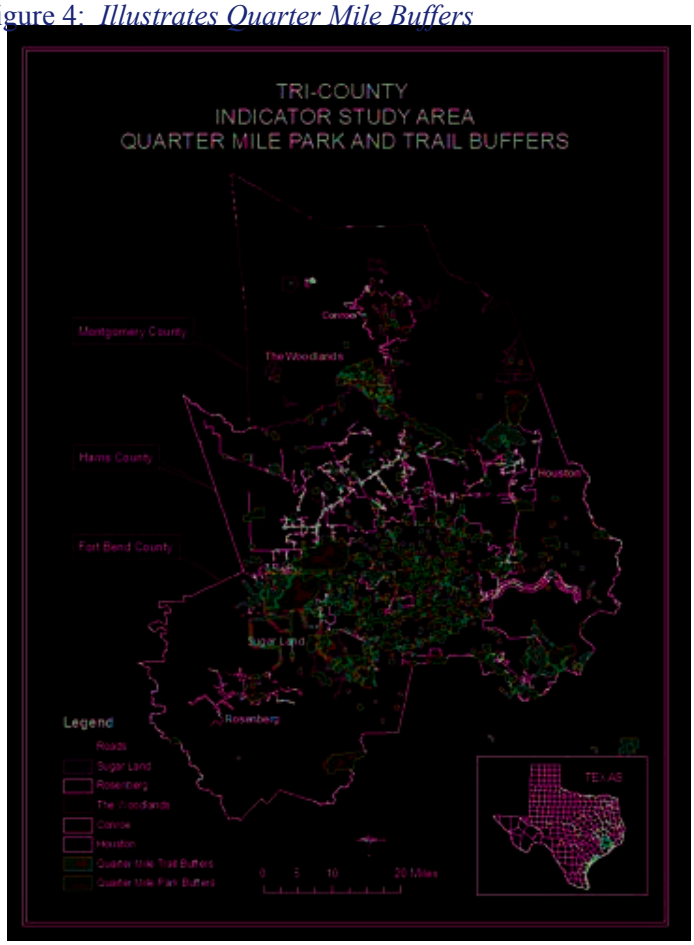


When communities participate in collaborative endeavors with a goal of increasing park and recreational services, they benefit by sharing resources and costs and reducing redundancy of services. It is interesting to note that Fort Bend County's statistics reflect the results of collaborative endeavors among Harris and Fort Bend Counties as well as Missouri City. Fort Bend currently has 67 major existing or planned master-planned communities. The results of future comparisons of a quarter mile service area should increase, if Fort Bend continues to implement a collaborative model among counties, cities, and developers.

Quarter Mile Buffers

While 2006 statistics for a park and trail quarter mile buffer were not available for Houston, a 2006 calculation of a quarter mile buffer for park land reported that 27% of the population living within the city of Houston lived within a ¼ mile of a park.[ix] There is a great need for updated trail data to show the positive impact it is having in Houston and Harris County. Further, for a more comprehensive indicator of how well the City is meeting the recreational needs of its residents, it is necessary to examine other evaluators.

Figure 4: *Illustrates Quarter Mile Buffers*



Statistical measurement provides a gage from which to compare quality and quantity of park service, but care must be given to the conclusions formed from these statistics. There is no one standard which can adequately measure all types of communities. The characteristics of a community may obscure the facts. For example, sparsely populated rural areas and small towns may not support close-to-home neighborhood parks but may have access to large open spaces in agricultural or forestry use.

Where Are Next Steps?

The last decade has been crucially important for the development of park space in the region. Parks are now an accepted issue on the public policy agenda, and cities recognize that parks impact their economic competitiveness and ability to draw talent to the region.

Infrastructure for parks development is not distributed uniformly across the region. Further, each county and city is unique with regard to its approach to acquiring and managing park and green space. The Harris County Parks System dates to the beginning of the century, having acquired its first public park, Clear Lake Park, in 1912.

Harris County has tracked data consistently over the last decade, and has recently conducted a county-wide poll on attitudes towards parks for use in planning. In contrast, Montgomery County formed its parks department in 2000 and is currently at work on its first Parks Master Plan.

In the last decade an increasing number of cities have published Parks Master Plans. Cities and counties have begun to set clear and measurable goals. In the next decade, leaders will need to refine these goals and work together to achieve them. The goal of 20 acres of park space per 1,000 residents is a stated goal of Harris County, however park planners state that it needs to be reviewed to assess whether it truly meets community needs.

There have been significant challenges to the development of parks and trails in the last decade. Limited budgets and the rising price of land are constant, fundamental obstacles. Other obstacles include bureaucracy in securing parkland. The difficulty of obtaining consistent, reliable data is persistent, underscoring the need for centralized reporting.

In particular, there is a need for reliable data on the extent to which MUDs are creating new parkland. In 2003, the 78th Legislature gave MUDs this new role. Additionally, more data is needed on connectivity opportunities. Connecting parks and trails with commercial and residential communities could be a "make or break situation" and contribute to mobility in the future.

In this study, many entities reported park data for only 2008, making it hard to draw conclusions. All county and city park directors were invited to participate in a meeting prior to the data collection process. At this meeting, all contributing agencies agreed on a standardized set of criteria by which to measure progress. However, many park agencies have limited staff and could only participate by phone and email. Because of the study's complexity, measuring progress on Parks & Trails is one of the most time intensive indicators of quality of place. Input from the tri-county area was needed throughout the process to ensure consistency. In the future a commitment is needed by all agencies to continue measurements against these benchmarks. Finally, in many cities, as mentioned in the 2007 Indicator Study, it is recommended that a more in-depth study include detailed analysis of population density and demographics to completely understand which areas have the greatest park needs.[ix]

Major accomplishments in the last decade are attributed to a long list of individuals and organizations working effectively together. A few outstanding partnerships are described below.

Creative Partnerships - A key to the Future

Funded in large part through grants, bonds, development corporations, and parkland dedication funds, recent park projects have increasingly relied upon wide-ranging coalitions spanning the public and private sectors to aid in their development. The combined efforts of organizations such as Houston Parks and Recreation Department (HPARD), Harris County Flood Control District (HCFCD) and Houston Parks Board (HPB) working in concert with the Mayor of Houston, county park commissioners, civic groups, and businesses have created a better, more integrated park system than was available just a few years ago.

A number of partnerships have been successfully formed with MUDs, county flood control districts, public schools, master planned community developers, and the Texas Department of Transportation. This heightened level of cooperation stands as a substantial accomplishment in itself, as these established networks will aid the development of future parks projects.

Because of the close proximity and interconnectedness of the three counties participating in this study, many residents living in one community work or spend leisure time in neighboring communities. The cooperative efforts among county, municipal parks and recreational agencies can be financially beneficial in reducing duplicate facilities and services, combining resources and efforts, and sharing expenses. The Spring Creek Greenway is a good example of this.

Spring Creek Greenway

The development of the Spring Creek Greenway is a joint effort of Harris County Precinct 4 and Montgomery County Precinct 3, which when completed, will create a 33-mile linear park system and will connect and preserve more than 12,000 acres on both sides of Spring Creek between FM 2978 in Spring, TX and U.S. 59 in Humble, TX. The trail system, which utilizes tracts of county and Harris County Flood Control District-owned land, will connect several public park systems. This collaborative venture will provide recreational and educational opportunities, protect the wildlife habitat of the urban forest, offer a buffer against flooding, and improve air quality.

Brays Greenway

A second example of an innovative and public-private partnership is Brays Greenway. Four years ago, the Houston Parks Board recognized a window of opportunity to create a system of connected parks and trails along Brays Bayou in partnership with HCFCD. It became "Project Brays", a $450 million Flood Damage Reduction Project. The HPB and HCFCD began acquiring land to create a continuous patchwork of parks and green space along the banks. The City of Houston participated by transferring key properties to the HPARD to be preserved as parkland along the greenway. HPARD has committed to maintain the trails and parkland along the Brays Greenway.

The University of Houston, a neighbor of the Greenway, also contributed to the Brays Greenway by dedicating approximately 14 acres of its campus along Brays Bayou as public parkland.

Ultimately, the project will connect 30-miles of uninterrupted trails and greenspace from the Ship Channel to the Addicks-Barker Reservoir. The Brays Greenway will connect business centers, residential communities, educational facilities, and cultural areas, including Texas Southern University, University of Houston, Hermann Park, Mason Park, the Museum District, the Texas Medical Center, and a new Metro rail system at MacGregor Park.

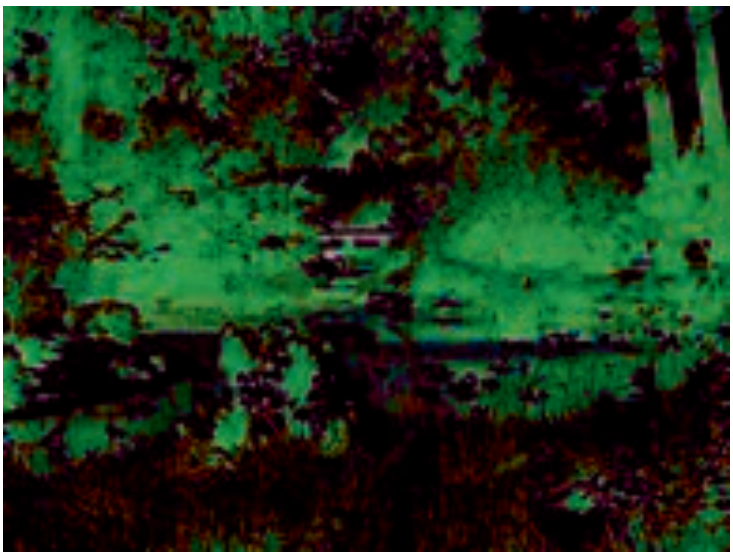
A central accomplishment of the past decade has been park acquisition, notably by Harris County. In 2003, three of Harris County's four park precincts listed land acquisition as their number one priority. With more than 3,714 acres in parkland acquisition and 1,262 acres procured for nature and conservancy areas in Harris County, the campaign to expand and create new parks made progress.

Houston Wilderness

The region has also undertaken innovative projects including the Houston Wilderness organization's 2006 "Green Ribbon" proposal to circle Houston in parkland. Already, the Parks and Recreation Departments of Rosenberg, Sugar Land, and Missouri City have partnered with private and non-profit organizations to implement the first stage of the Green Ribbon program. Once constructed, the Brazos River Paddling Trail will establish a park stretching 125 miles and connecting communities from Fort Bend County to the Gulf Coast.

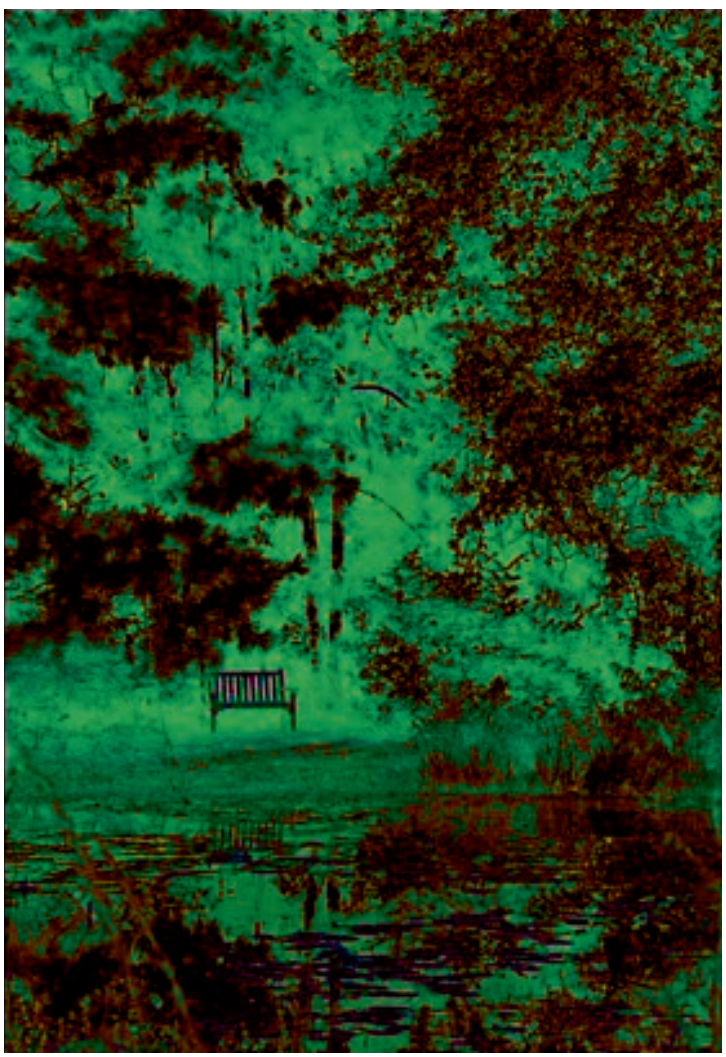
Maintaining the region's park improvements in the future requires building upon recent accomplishments. With large population growth projected, the region must race to provide additional park space. At the same time there are extraordinary opportunities for the region's parks. In coming years, parks and trails will more frequently be developed in conjunctions with wetlands, storm-water detention basins, and surface water supply reservoirs. This approach will significantly boost park acreage and provide an efficient use of available resources.

More research is needed to determine which areas are currently underserved. Given the unsettled economic climate, forming a broad based, coordinated coalition of groups will be essential to the task of creating future parks.

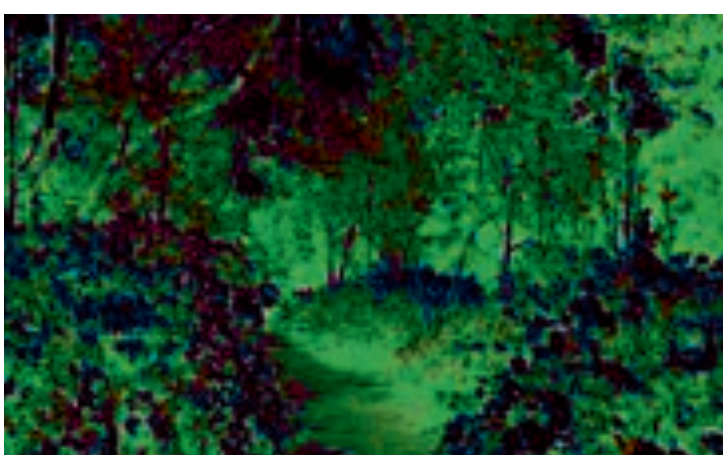


Hermann Park - Japanese Garden

Effective partnerships could enable the region to receive its fair share of federal and state grants for parks. Future endeavors to improve parks will have to overcome the persistent challenge of underfunding in the parks system. County Commissioners have proven themselves capable in developing and acquiring new parks, but only when adequate funds are budgeted. The commitment should be ongoing, in good and bad economic times. While continuing to increase parks and trails in the face of expected growth will be a tremendous task, the region now has strong positive momentum and a solid foundation for future progress.



Houston Arboretum



Azalea Trail

CHAPTER 3: TREES

Authors: David Hitchcock, Director of Sustainable Transportation Programs, and Zach Vernon, GIS/Remote Sensing Research Associate, Houston Advanced Research Center

Executive Summary

Expecting to encounter the barren Texas landscape of the movies, first-time visitors to the greater Houston region frequently comment on how green the landscape is. Trees are primarily responsible. Without majestic mountains or rushing rivers, trees are the key element of the greater Houston region's landscape. They comprise an important relief to an otherwise flat landscape and make up the region's urban forest. They are a particularly vital and visual features of the region's quality of place.

The purpose of this chapter is to study and report on the condition of trees and the urban canopy. The Center for Houston's Future 2007 publication entitled *Counting on Quality of Life: An Environmental Indicator Report* reported that, between 1992 and 2000, 486 square miles of tree canopy was lost. Two years later, this report finds that the region is still losing substantial tree cover. Between 2000 and 2005, 194 square miles were lost. Thus the total loss of tree canopy in the greater Houston region between 1992 and 2005 is 680 square miles. This loss equates roughly to the physical size of the city of Houston, and since 2005, tree loss has continued.

The good news is that the primary cause of this tree loss is growth and development, which means that the region is growing and creating opportunities. The bad news is that most growth is by way of low-density sprawl, and sprawl means death to many trees.

Adding to the canopy loss due to development was the loss due to Hurricane Ike plus a severe drought. Galveston County suffered the most physical and psychological effects of this double whammy.

There are actions that can be taken to stem this downward trend. Many county and local officials are supportive and are leading tree planting and conservation activities. Some cities and counties that do not already have tree planting and protection ordinances are investigating what would be most effective for their area. Significant numbers of non-profit organizations are working in and around the "tree issue" and innovative partnerships are springing up throughout the region.

Trees provide shade and character to Houston's neighborhoods and are essential to the region's environmental health. They mitigate air pollution, provide energy savings, can aid in storm water management, create shade for pedestrians and public gathering areas, and help to offset urban heat island effects.

Introduction

Massive trees felled by Hurricane Ike in 2008 and the damage in 2009 from drought conditions have produced a tree population that is stressed and susceptible to disease and further damage. Public agencies, private citizens, and civic organizations had already accomplished much in the way of tree planting. From 2000-2008, approximately one million trees were reported planted in the greater Houston area. More than $50 million was invested, excluding the time of thousands of volunteers who helped make this happen. Also excluded are the trees and expenditures of property owners who added trees to their individual properties.

A city's urban tree canopy usually has an inverse relationship to its population growth and urban sprawl. The Houston region is no exception. It is challenging to add new development in areas with extensive tree cover without substantially reducing this canopy. Thus, it is doubly important to protect existing resources where possible and to restore trees as part of the development process itself.

The greater Houston area, comprised of almost 7,600 square miles in an 8-county region, has experienced annual tree cover losses of more than 50 square miles per year from 1992 to 2005. In 2000, the total forest land cover was 2,312 square miles.[i] The rate of loss appears to have subsided between 2001and 2005, but the causes have yet to be examined. Are we doing a better job of retaining existing tree cover? Has urban development or other changes in land cover been at work? Is the tree population increasing in areas not being developed, helping to offset losses? Are better regulations and development practices being used in the region to protect the urban forest? These questions could only be answered with more data on detailed forest cover characteristics and analysis of factors affecting tree loss in the region.

Regional Perspective: The Need for Good Information

A regional effort, this is the first year that this study has attempted to capture data on tree planting outside Harris County. It is a deliberate attempt to paint a broad perspective of the tree population. Data on tree planting were collected from Fort Bend, Harris and Montgomery Counties, as well as the cities of Houston, Sugar Land, Rosenberg, Conroe, and The Woodlands. With some exceptions, data on many tree planting efforts simply did not exist within local government records.

The difference in practices from county to county is significant. In Montgomery County, no data were kept on tree planting activities. It was reported that there were no county-wide tree planting programs from 2000-2008. However, the County has plans for tree planting projects in 2009.

In Fort Bend County, respondents indicated that there had been no coordinated tree planting prior to 2008. During 2008, 10,000 trees were donated to the county for planting. The City of Rosenberg followed a similar pattern, reporting 816 trees planted in 2008 but no prior planting efforts. The City of Sugar Land was able to provide data covering all of the study period from 2000 to 2008, with planting reported each year.

In general the four cities studied, i.e. Conroe, The Woodlands, Sugar Land, and Rosenberg, provided more data on park space. Information on park space was more readily available than tree planting. Since parks are connected with physical infrastructure such as land, buildings, and improvements, it is more straightforward to track than program activities, such as tree planting. Local government officials and staff would need to consider tree planting a higher priority in order to track annual progress.

Cities with established specific tree planting goals generally track tree planting data, even setting specific goals for the number of street trees to be planted each year. Likewise, cities that receive grants or funding from outside sources for specific tree planting programs, are more apt to have activity measures. It is common for grantors to request a report on the results of the activity. It is also possible that cities in the Houston area plant trees annually, but simply do not track them as a separate expenditure.

In addition, cities and counties may require tree planting as part of the development process, but may not track implementation. Some commercial and residential developments in the Houston area have planted large street trees as a feature of development, but these remain unreported by either the governmental entity responsible for the roadway or the developer.

Why are trees an important component of quality of place?

Improve Air Quality

Houston's regional forest helps improve air quality by reducing temperature, directly removing pollutants from the air, and reducing building energy use, including the consequent pollutants from power plants. Annually, Houston area trees remove an estimated 60,575 tons of air pollutants regulated under the federal Clean Air Act[ii] for an annual economic value of nearly $300 million.[iii]

Sequester Carbon Dioxide

Trees also play an important role in the carbon cycle and associated climate change. They moderate the amount of carbon dioxide in the atmosphere through the process of photosynthesis, which absorbs CO_2 and emits oxygen. As trees grow, they sequester or store carbon. Houston's regional forest stores an estimated 39.2 million tons of carbon, valued at $721 million. Rice University scientists are currently examining which tree species have the greatest potential for carbon sequestration and removal of pollutants, such as fine particulates, from the air.

Reduce Energy Use

Figure 1: *Trees and Energy Conservation*

Source: Trees and Vegetation, 2008, Reducing Urban Heat Islands: Compendium of Strategies, U.S. EPA, p. 4.

Trees reduce energy use by shading heat absorbing surfaces, by the evaporative cooling effect of their leaves, and by blocking winter winds. For example, afternoon air temperatures in heavily treed areas such as Memorial Park have been found to be 5 to 6º F cooler (89ºF vs. 95ºF – July).[v] Trees are especially beneficial in dense urban areas such as Houston that rely on air-conditioning throughout much of the year.[vi] The regional forest saves energy in both the heating and cooling seasons, with the largest savings in the summer. Reducing energy use also avoids the carbon emissions inherent in energy production. The value of combined energy savings and avoided carbon emissions due to tree cover is $131 million per year.[vii] A single mature tree that shades a Houston home saves almost $50 per year in electricity costs.[viii]

Reduce the Heat Island Effect

Urban heat islands *Figure 2* result from the loss of tree cover combined with a concentration of buildings and concrete. Heat island mitigation occurs through tree planting and conservation as well as actions to increase solar reflectivity of roofing and paving. The City of Houston has already adopted cool roof requirements for low slope (flat) roofs as part of its building code, both for new construction and re-roofing.

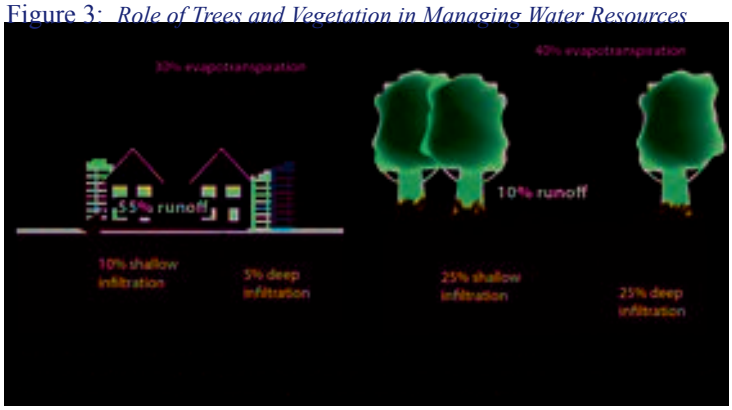
Figure 2: *Urban Heat Island Graphic*

Source: Urban Heat Island Basics, 2008, Reducing Urban Heat Islands: Compendium of Strategies, U.S. EPA, p. 4 (no temperature scale)

Reduce the Threat of Flooding

In areas prone to severe storms and heavy rainfall, trees help manage storm water runoff. Leaves and branches catch and slow rainfall runoff, allowing more time for evaporation and reducing peak flows *Figure 3*.

Figure 3: *Role of Trees and Vegetation in Managing Water Resources*



Source: Urban Heat Island Basics, 2008, Reducing Urban Heat Islands: Compendium of Strategies, U.S. EPA, p. 7.

What is the community goal?

City of Houston ordinances and Harris County regulations reflect the importance of trees in three ways: tree planting by public agencies, tree planting by citizens, and protection of existing trees. However, some regulations are complex and limited in scope, particularly with regard to tree preservation. The lack of emphasis on tree preservation could be detrimental, particularly in unincorporated areas not covered by tree protection ordinances.

Tree planting by public agencies

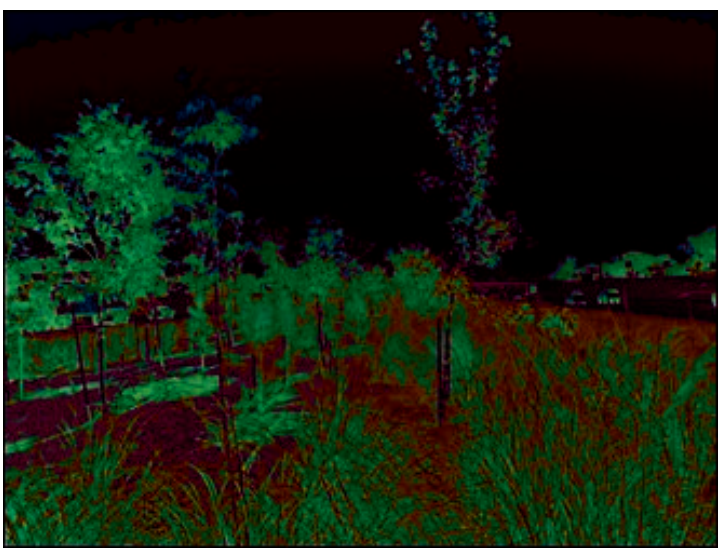
For almost 20 years, the City of Houston has devoted funds to tree planting. In January 1990, City Council passed a resolution stating "the policy of the City of Houston shall be to expend a maximum of one-percent of construction costs of roadway and facility improvements for landscaping and beautification."[ix] Ordinances have also passed that require tree replacement or compensation for protected trees in public rights-of-way. When protected trees are removed from street rights-of-way, either trees of equivalent total diameter must be planted or compensatory funds paid to the tree fund, which is used exclusively for tree planting. The City also encourages tree planting by private groups in public rights-of-way, esplanades, and parks, and supports a program of providing free trees to encourage citizens to put them on their own property.

The City of Houston has also promoted the "Million Trees + Houston" initiative, a public/private effort to increase one of the area's great natural resources. The City has partnered with Texas Department of Transportation (TxDOT), Harris County, Trees for Houston, and the Quality of Life Coalition to set a goal of planting one million trees. In support of this effort, businesses were asked to participate in the 2008 and 2009 "Gift of Trees" program, for which the City matches one-third of the tree cost with the first $1.5 million donated by companies.

Harris County landscape regulations[x] require tree planting in connection with its own public buildings, commercial establishments, and single family residential construction. One street tree is required for every 30 linear feet of street frontage and for every 10 parking lot spaces. Regulations also contain provisions for protecting existing trees. As a matter of practice, additional funds are devoted to tree planting, with the largest tree investments in the County being made by the HCFCD. HCFCD has long recognized that "trees play an integral role in fulfilling the elements of the District's mission" of storm water management.[xi]

Other governmental agencies also plant trees as a matter of practice. One of the largest of these is the Texas Department of Transportation (TxDOT) which plants trees along Texas highways and has created the Green Ribbon Project to reforest all of the safely plantable areas within Beltway 8. Using both federal and state funding, TxDOT is one of the most visible tree planting agencies.

Figure 4: *Freeway Tree Planting*



Source: TxDOT tree planting on Highway 288 and Southmore,

Tree planting by private citizens, developers, and voluntary efforts

Both Houston and Harris County require tree planting by private interests in connection with development. Their ordinances require that one street tree be planted for every 30 feet of street frontage and for every 10 parking lot spaces in commercial development. A tree must be planted for every single family lot under 5,000 square feet, and two for every larger lot. Houston allows payment of a fee to a specified tree fund, in lieu of the required planting.[xii]

Trees for Houston (TFH), a privately funded nonprofit organization, has provided the longest and largest sustained non-governmental effort to plant trees along Houston streets.[xiii] Recent plantings have been coordinated with companies and/or schools, and carried out with personal donations for planting individual or small groups of trees. TFH has partnered with CenterPoint Energy in a pilot project to include shade tree planting as part of an energy-efficiency outreach program. TFH reports planting more than 42,000 trees in 2007 and 2008. During the 2008-2009 planting season, nearly 9,000 trees were planted in areas affected by new development, including those areas damaged by Hurricane Ike.

Many of Houston's neighborhood and civic organizations are actively involved in tree planting efforts. Area businesses and non-profit organizations are involved or support tree planting, including the Houston Parks Board, The Woodlands G.R.E.E.N., and Keep Sugar Land Beautiful.

Tree preservation

In spite of the loss of tree cover, tree preservation policies are limited. The City of Houston requires tree preservation in rights-of-way and within building setbacks of commercial and multi-family residential properties if the tree is a certain species and/or meets size requirements. Tree removal is authorized only if the tree is in poor health, unsafe, or blocks the installation of utilities, sidewalks or driveways. The City may authorize tree removal under other conditions, subject to payment of a protected tree fee of $103 per caliper inch, or if trees are re-planted on an inch-for-inch basis, subject to a replacement cap.

Harris County's tree preservation policy covers designated trees in public rights-of-way. Trees of 12 inch caliper or more are protected, but they may be moved within the right-of-way if they are smaller. They may also be replaced by trees at least 3 caliper inches each that total at least the number of caliper inches removed. In summary, Houston and Harris County limit tree preservation to larger trees located in public rights-of-way.

Other municipalities have varying tree protection policies, some of which require replacement of trees or fees paid if trees are removed from private property outside building setback lines. Conroe has extensive provisions for tree protection including requirements for tree analysis and tree clearing permits. In 2008, Conroe officials strengthened tree preservations rules to levy fines on developers that clear trees without approval.

The Appendix contains information on some municipal ordinances that govern trees, landscaping, and tree protection. *Table 1* identifies ordinance types and where additional information may be found.

Table 1
Municipal Ordinances in the Houston Region
Tress/Landscape Requirements

Community	Ordinance Type	Chapter	Article
Baytown	Landscape	18	XIV
Bellaire	NA	NA	NA
Bunkerhill	Tree	10	VI
Conroe	Tree	4	VI
Dickenson	Tree	16.1	
Friendswood	Landscape		
Hedwig Village	Tree	14	VII
Houston	Tree & Landscape		
Jersey Village	Landscape	14	XII
Lake Jackson	Trees & Landscape		
League City	Tree	111	
Pasadena	Landscape	9	X
Pearland	Tree	29 ½	
Piney Point Village	Tree	66	II
Seabrook	Tree	30	VII
Shenandoah	Tree	98	
Shoreacres	Tree	70	
Spring Valley	Tree	3	3.1000
Tomball	Landscape	44	
Webster	Landscape	90	

Source: Houston Area Urban Forestry Council
http://haufc.net/newpages/ordinance.html
NOTE: Municipal codes can be accessed at http://www.municode.com/

Figure 5: *Tree Planting By Volunteers*

Keep Sugar Land Beautiful 2007 Tree Planting
Source: Keep Sugar Land Beautiful

How can progress be measured?

The best measure of success is total tree cover within the region, also called tree canopy.[xiv] Satellite photo analysis is an essential method for measuring tree cover to determine the total effect of tree planting efforts as well as tree growth, loss, and conservation. Tree planting should be independently measured to evaluate the impact of local government and private efforts. Thus, two indicators that can be used for measuring progress in the Houston area include: tree cover and public funding of, and requirements for, tree planting.

What is the current situation?

Regional tree cover has been measured previously in two major studies: Houston Green and the Urban Forest Effects Model (UFORE) project. Data from the UFORE project was presented in the 2007 publication entitled *Counting on Quality of Life: An Environmental Indicator Study*. In 2000, several Houston organizations, Texas Forest Service, and American Forests teamed up for a project known as "Houston Green,"[xv] which included analysis of tree cover change from 1972 to 1999. In 2001, a grant from the U.S. Department of Agriculture provided funds that helped establish an improved baseline for urban forest analysis.[xvi] This project analyzed tree cover in the 8-county region: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties. Researchers applied the UFORE computer program developed by the U.S. Forest Service, to characterize the structure, environmental effects, and value of the area's tree canopy. In 2005, the results of the UFORE analysis were published in Houston's Regional Forest.[xvii]

The UFORE report concluded, that trees covered 28.4% of the region's total land in 2000. Between 1992 and 2000, this coverage declined by 17%, or 486 square miles, mostly as the result of land use changes. Over this time approximately 78 million trees were lost,[xviii] due primarily to commercial and residential development. This process should be measured over time as it relates to the impact on the region's tree population.

As part of the 2009 publication entitled *Counting on Quality of Place: Air Quality, Parks & Trails, Trees*, NOAA Coastal Change Analysis imagery was used as an indicator of changes since the UFORE study.[xix] This analysis shows that the region's tree cover continued its decline from 2000 to 2005, although possibly at a slower pace. Change in forest cover designations declined 24% or 8 million trees, from 1992 to 2001, as compared to 17% over a similar time period in the UFORE analysis. The rates of annual loss are shown below.

Table 2
Houston Region Tree Cover (1992-2005) : NOAA Coastal Change Analysis

Year	Sq. Mi. of Forest*	% of Total Region Area	Sq. Mi. Loss Per Year
1992	2,817	32.02%	-
1996	2,386	27.12%	107.7
2001	2,226	25.29%	32.2
2005	2,137	24.29%	22.0

*Forest" includes image components categorized as forest in the NOAA imagery, i.e. trees found in sufficient densities to register at the 30m resolution.

This rate of loss illustrated in *Table 2* is substantially lower than the other reported periods. There are many possible explanations for these differences; however, no analysis has been performed to identify specific causes. Possibilities include retention of existing tree cover, more rapid tree growth in previously unforested land, changes in land cover due to property ownership or agricultural activities, and/or improved regulations and development practices. A detailed comparisons of areas experiencing extensive development with areas of extensive forest cover change could help to understand causes. Care is needed to ensure that any of these changes are measured at the same scale and time period.

Table 3: *Houston Region Tree Population (UFORE, NOAA)*

	Area (sq. mi.)	Forest (sq. mi.)	Number of trees (millions)	Density trees/sq. mi.
Houston Region (2001-02 UFORE)	7,581	2,226	663.1	87,000
Houston Region (2005 NOAA)	7,581	2,137	655.4*	86,453 [xx]

*based on loss of 89 sq. mi. of trees from 2001 - 2005 (NOAA) with 87,000 trees/sq mi.

Figure 6: *Loss of Forest Area in Houston: 1992-2005*

Source: Houston Advanced Research Center, 2009.

As shown in *Table 3*, the total population of trees in the Houston region was estimated to be 663 million trees in the 2001/2002 time period, roughly 135 trees per person.[xxi] Land cover defined as "urban" was 18% of total land cover and accounted for an important 84 million trees. These comprise about 13% of the region's tree population, but are particularly valuable to the region due to direct energy savings, created by their shade, their role in storm water runoff and water quality, and their contribution to the quality of the urban environment and economic benefits.

Continued acquisition and evaluation of tree and forest data are needed to better track changes in tree cover over time. Each city needs a separate assessment in addition to assessment at a regional level. Without such measurements, progress in tree planting and conservation is difficult to track, particularly with continued growth and development. For example, extensive tree planting or conservation in a smaller community would not be observed in regional trends, nor would tree loss in a rapidly developing community. One city examined experienced a 6% loss from 2001 to 2005 while the overall county tree loss was only 3.6%. Small area measurements would be more helpful to community efforts in achieving tree related goals (e.g., a goal of restoring existing tree canopy to year 2000 levels).

Figure 7
Typical Single Family Residential Landscaping

Source: Houston Advanced Research Center

One means to account for the number and expenditures on trees is to capture the information from public agencies as well as developers. As mentioned, several public agencies have reported the number of tree planted, but not total expenditures. Data sources have yet to be identified to measure the amount of private tree planting resulting from regulatory requirements.

Hurricane Ike

"It may sound strange, but what people are grieving most is the loss of thousands of our trees. Saltwater poisoned their roots. The oleanders and palm trees survived, but all the graceful old live oaks are dead. The oaks were all the same age, about a century old. They were planted after the Great 1900 storm killed off an earlier generation of Galveston's trees."
Source: Galveston high school student, NPR Weekend Edition Broadcast, Sept. 13, 2009.

Hurricane Ike was one of the most damaging storms to strike the United States. Damages along the Gulf Coast were estimated to be more than $24 billion. A visible portion of this damage was tree loss. Loss of electric power, blamed on fallen trees, was a problem for many residents. The same time, the sight of fallen trees was often the expression of sorrow as people lamented their loss. Likewise, there was relief that many trees survived.

Aerial photography along the storm path began the day after the hurricane in an attempt to analyze images and to estimate tree loss/damage using computer image analysis. For the most part, these efforts were unsuccessful. Although the sheer devastation was massive, the quantity of vegetation loss was small in comparison with total volume of remaining tree mass. Heavily impacted areas along the coast may have experienced a larger percentage of tree loss, but forested areas to the north showed little observable change in canopy coverage. Today, there is visible evidence along roads and freeways of tree disease that was likely brought on by storm damage and the ensuing drought. Pests, such as the pine park beetle, add to the damage by attacking stressed trees.

The University of Florida launched an analysis of Houston's damage and debris following Hurricane Ike in an effort to better model debris amounts by detailed locations. Such modeling could help cities more accurately assess storm damage both pre- and post-hurricanes. Such data are needed for damage assessment and loss valuation. Because of the UFORE study, there were sufficiently detailed data on trees and vegetation from the study's sample areas and Texas Forest Service researchers. The research team went back to some of these areas to gather post-hurricane data similar to the baseline data from UFORE. These data were then used to help test modeling improvements.

Often tree planting projects are organized by multiple entities to share costs and responsibilities. Reporting on these projects is susceptible to double counting. Some tree planting, encouraged and supported by public entities, is achieved through citizens' actions on private property, and is not reported at all. Today, new web-based mapping tools and databases could greatly improve such a system for the greater Houston area.

From 2000-2008, almost one million trees were planted by public and private efforts, according to organizations that reported as part of this study. Total expenditures were nearly $51 million, which may understate expenditures due to unreported data. Based on average reported expenditures, the total might exceed $75 million.

HCFCD efforts and TxDOT's Green Ribbon Project are the largest public tree planting programs. TxDOT accounts for more than half the reported tree planting during the last eight years. For many years, HCFCD has planted trees as part of its goal to implement flood control projects that respond to community values and to achieve the functional benefits of trees on storm water management.

TxDOT initiated the Green Ribbon Project to improve air quality and beautify roadways throughout Texas. Planning began in the Houston area in 1997 with the first planting project completed in 1999. The Green Ribbon Project planted 250,000 trees during its first five years. Since 2003, TxDOT substantially increased funds in the Houston region planting 40,243 trees in 2004, and spending $4.5 million. In 2005, 67,733 trees were planted at a cost of $8.1 million. In 2006, planting expanded with 100,211 trees at a cost of $10.2 million. In 2007 and 2008, TxDOT planted over 250,000 trees, bringing the five-year total to 461,000 trees. With expenditures of $38.9 million over this period of time, plantings costs averaged roughly $84 per tree. Based on the success of the Houston project, other cities throughout Texas are working with TxDOT to implement the Green Ribbon Projects.

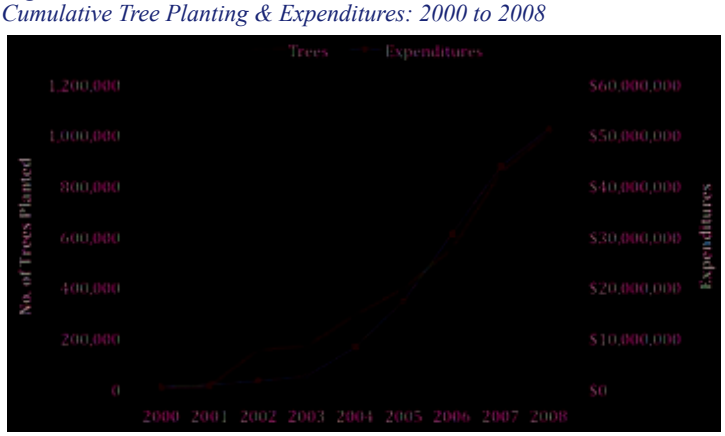
The HCFCD has planted 71,000 trees since 2002 and over 2,000 seedlings. From 2006 to 2008, tree planting increased to an average of 20,000 trees per year. With expenditures over this period totaling $4.7 million, the average cost per tree planted has been roughly $66.

Planting data from other public entities, including the City of Houston, is more difficult to compile since these expenditures occur among several departments. During the past nine years, City departments report planting 288,167 trees, 211,000 of which were planted by the Houston Airport System. Tree planting expenditures are usually included in individual construction contracts, general landscaping budgets, and departmental budgets, and are not separately reported.

A coordinated data collection system and uniform collection protocols would greatly assist measuring tree planting. An example of good data management is the Houston Airport System's participation in the January 2007 planting event, the largest such event in regional history. Data generated from that event documented that more than 20,000 five-gallon trees were planted in one day as part of the Houston Area Freeway Forestation Project. Information from similar, though smaller, public-private efforts has not been captured in any systematic or comprehensive manner. Tree planting data *Appendix A* contains the most comprehensive record of tree planting data and expenditures to date in the Houston area.

Figures 8 and *9* show the growth and commitment in expenditures and number of trees planted between 2000 and 2008.

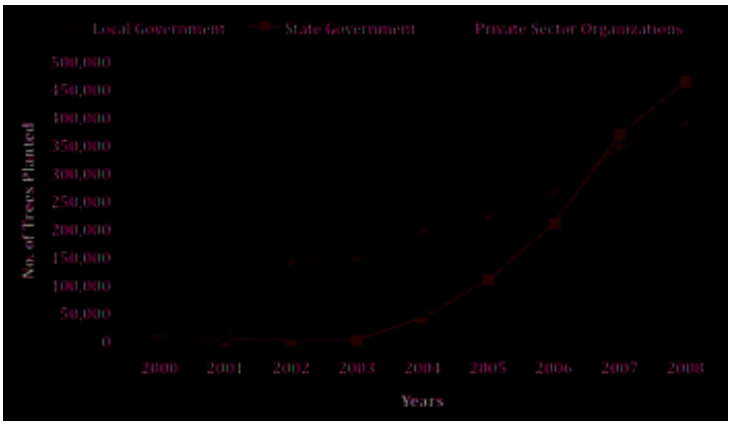
Figure 8
Cumulative Tree Planting & Expenditures: 2000 to 2008



Source: Center for Houston's Future survey of public and private organizations tree planting activities, 2009.

Note: This chart does not represent all planting and expenditures by the organizations that submitted information for this report. It is limited to the reported data, which in many cases included the number of trees planted, but not the expenditures.

Figure 9
Cumulative Tree Planting by Types of Organization



An additional measure of the region's commitment to tree canopy is the amount of grant money given for the purpose of tree preservation. Texas Forest Service (TFS), through its grants and hands-on support to local governments and planning agencies, is an important factor in building and preserving trees and the tree canopy. In addition to funding for tree planting, the TFS provides funds to protect the urban forest in the Houston region. TFS distributed approximately $400,000 in matching grants from 2000 to 2007, resulting in a total value of almost $800,000. Grants were given to cities and non-profit organizations for urban forestry program development, urban forestry awareness programs, ordinance development and urban forestry staff positions. Some tree planting resulted indirectly from these grants and the matching funds, although that was not the grant focus.

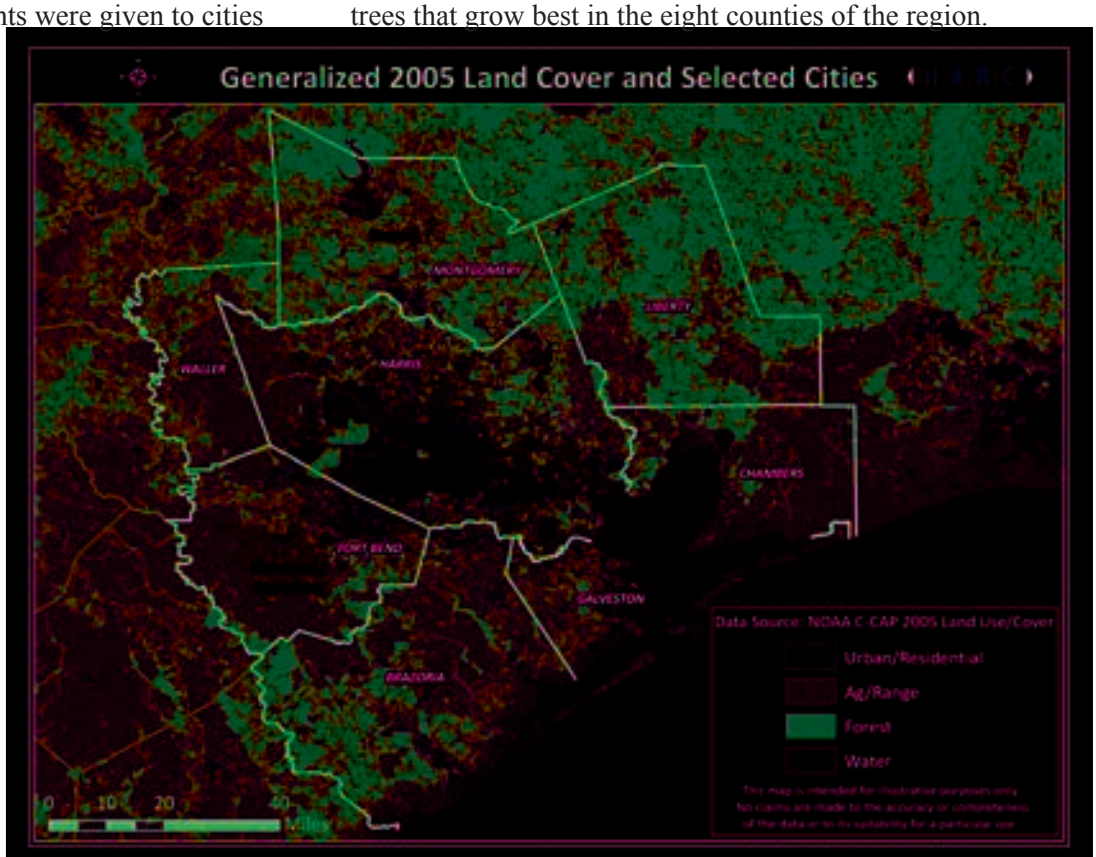
In addition, the TFS received $500,000 from U.S. Forest Service for the UFORE project (described elsewhere) and, with matching grant funds, the project totaled approximately $1 million. This project provided valuable baseline information and analysis that has been helpful in quantifying the characteristics and value of the region's urban forest.

Where and What to Plant

This region of Texas encompasses 10 distinct ecosystems within 60 miles of downtown Houston, including the coastal marshes, Big Thicket, pine woods, Trinity Bottomlands, Columbia Bottomlands, prairie systems, Post Oak Savannah, estuaries, bays and bayou wilderness. Consequently, there are many considerations when deciding what kind of tree to plant and where. For a tree to have a high likelihood of survival it must be planted properly and in the right place. Fortunately there are also several useful information sources that can help guide decisions. Some helpful websites are listed in *Appendix C*. Along with examples of trees that grow best in the eight counties of the region.

Figure 10
Houston Regional Land Cover

Source: HARC analysis of NOAA-CAP 2005 Land Use/Land Cover



Where do we go from here?

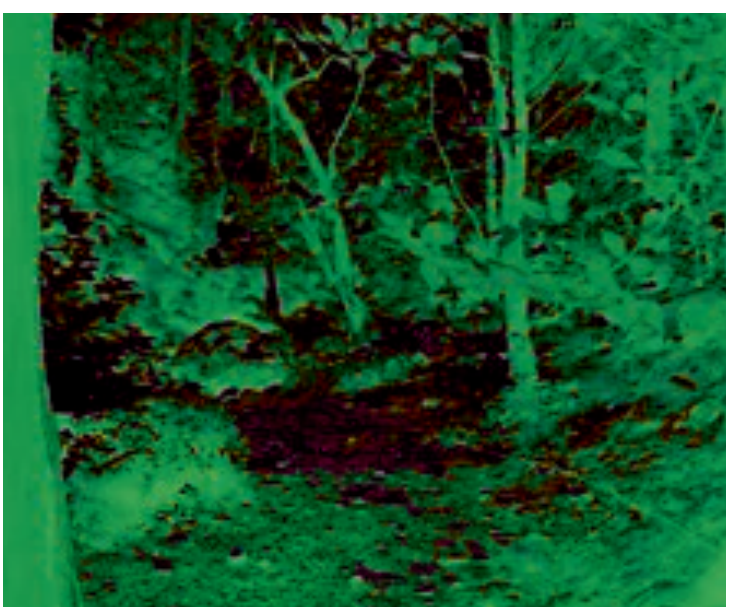
The region's trees and urban forest are of great importance to the region's quality of place, but without accurate and detailed information, it will be difficult to determine progress, effectiveness, and challenges. As the business community is often quoted, "if we don't measure it, it cannot be managed or understood." Continued measurement is an essential step for a region in which many organizations and individuals affect the region's trees. It is also known that adequate data can be compiled to help determine the extent of the region's tree canopy. The UFORE analysis provides baseline measures for 1992 and 2000. The NOAA imagery, used for this report, serves as an indicator of changes since 2000. However, tree cover data needs to be thoroughly updated to be useful for tracking and assessing progress at the regional and sub-regional levels. Such data and analysis are critical to determine if efforts to sustain and increase tree canopy area-wide are effective.

Between 2000 and 2005, the region lost 194 square miles of tree canopy, leaving the region with a total loss of 680 square miles between 1992 and 2005, roughly the size of the City of Houston. Since publication of the 2007 Indicator Study, *Counting on Quality of Life: An Environmental Indicator Study,* data became available for 2005. No data exists as of December 2009 to inform the region how much tree cover we lost between 2005 and 2008. The lag in the availability of the data presents a challenge to forming current and responsive public policies.

Tree planting data are presently inadequate in many respects to assess public sector efforts, whether for tree planting, associated expenditures, or the effects of regulations. Collecting, systematizing and analyzing data require a commitment from many governmental entities at all city and county levels. Governments need to establish routine methods to capture and maintain data on the number of trees planted and on tree-related expenditures. Harris County has begun a program based on vendor records, and the City of Houston has demonstrated an effective method through the Houston Airport System's planting. This level of detail is needed to establish benchmarks and measure progress in future years.

The area-wide trend of tree loss is a major concern for many reasons, including environmental, water resource, and economic benefits. Reviews in this report suggest these declines continue at substantial levels, although possibly slower than in previous years. More systematic periodic review of tree cover creates a valuable indicator of the environmental health of the area. Meanwhile, data gathered by this study show that large scale tree planting efforts have increased over the past five years due to coordinated efforts of many different public and private sector organizations.

What is next for the region? In addition to needed tools to help track planting progress and canopy change, a regional approach to canopy enhancement is needed. Fundamental to an effective regional approach is individual community goal setting and a regional entity to help organizations set, analyze and achieve their goals. The regional coalition, Texas TreePrint, convened community leaders in 2008 to successfully share best practices and to set a regional agenda. Continued momentum, in the aftermath of Hurricane Ike, is needed to build a network of leaders committed to the region's tree canopy.



CHAPTER 4: The Health Impacts of Air Quality, Parks & Trails, and Trees

Authors: Linda Highfield, Ph.D.[a], Patricia Gail Bray, Ph.D., Jane Peranteau, Ph.D., St. Luke's Episcopal Health Charities.

Tom Reynolds, Ph.D., University of Texas, School of Public Health, Institute for Health Policy.

Executive Summary

Our natural environment and our health are inextricably linked.[xviii] The recognition that the environment is an important component of health has a long history, dating back to ancient Greece.[xii] The beneficial effects of a healthy environment include lower rates of respiratory illness, obesity, mental illness, and domestic violence.[xii, xviii]

To understand the importance of Air Quality, Parks & Trails, and Trees as indicators of how the greater Houston region will sustain its place as a important city in the 21st Century, one where people want to live and work, it is essential to understand how these indicators affect the health and well being of the citizens in the region.

Much of the discussion in this chapter is generally published and accepted data, applicable to any area of the country. However, one specific study, commissioned by the City of Houston and conducted by the University of Texas School of Public Health, assessed the health risks from 1,3-butadiene, a known carcinogen, in a neighborhood near the Houston Ship Channel. The study found a 56% increased risk of acute lymphocytic leukemia among children residing within two miles of the Houston Ship Channel as compared with children living more than 10 miles away.

This is one study, in one neighborhood. Studies over long periods of time, focusing on the same populations, are very difficult and expensive. However, there is too much at stake to delay understanding the extent of the problem and devising solutions. At a minimum, more studies need to be conducted in neighborhoods where residents may be at risk.

What is the impact of Air Quality, Parks & Trails and Trees on the health of area residents and the Quality of Place in the region?

Houston is the fourth largest city in the United States, with a population of more than 2 million people, spread across an area of approximately 600 square miles.[viii, xxviii] Public health issues related to air quality and the public's access to and use of green space are ongoing concerns.[xvi] Lack of physical activity and urban air pollution are two of the top 15 worldwide sources of health impairment.[xi, xv]

The purpose of this chapter is to review the current environment in Houston and its impact on the health of the community. In particular, this chapter will focus on the public health effects of outdoor air pollution (ozone, benzene, and 1,3-butadiene), the tree canopy, and access to parks and recreation. While the effects of each indicator are felt throughout the greater Houston region, this report will focus on one "high-risk" area, as a case study of the potential health impacts of the local environment.

Air Quality

Empirical research extending across more than 35 years, and including thousands of scientific studies, provides unimpeachable evidence that exposure to air pollution at sufficiently elevated levels adversely impacts human health.[xvii, xxv] Exposure to air pollution has been linked to headaches, eye and throat irritation, wheezing, asthma, difficulty breathing, cancer, and even premature death.[xvii, xxv] Houston's air quality problems are well-known.[xi, xvii, xxv] They are highlighted in frequent articles in the area's major news outlets. On September 8, 2009, the Environmental Protection Agency (EPA) announced that many of the air pollution rules the state of Texas uses to regulate local industry do not comply with the federal Clean Air Act.[iii] The EPA currently considers Houston to be a severe non-attainment area, meaning that it does not meet federal standards for ozone levels. However, for 2009 when all the data are recorded, it appears that Houston will meet the current ozone standards for the first time since the Clean Air Act has been in effect.

Benzene

The health effects of benzene are predominantly related to blood functioning. Long-term exposure has been linked to anemia, excessive bleeding, lowered immune function, and cancer, particularly leukemia.[iv] The U.S. Department of Health and Human Services (DHHS) has determined that benzene is a human carcinogen.[iv] In women, benzene exposure has been linked to irregular menses and decreased ovary size.[iv] It is not yet known how benzene exposure affects the developing fetus or fertility.[iv] Toxicological studies in animals have shown that benzene exposure results in low birth weights, delayed bone formation, and bone marrow damage.[iv]

1,3-Butadiene

The health effects of exposure to 1,3-butadiene can be classified as both acute and chronic, and further sub-categorized by dose.[xxix] Acute low exposure levels may cause irritation to the eyes, throat, nose, and lungs.[xxix] Acute high exposure levels may cause damage to the central nervous system, with such symptoms as blurred vision, vertigo, fatigue, low blood pressure, headache, nausea, reduced pulse rate, and fainting.[xxix] The chronic health effects resulting from exposure to 1,3-butadiene are not as clear. Several epidemiological studies have linked exposure with an increase in cardiovascular disease and cancer.[xxix] Laboratory experiments of chronic exposure in mice and rats have shown a strong causal relationship between 1,3-butadiene exposure and cancer.[xxix] Animal studies have also found reproductive and developmental problems resulting from exposure.[xxix] The EPA has classified 1,3-butadiene as a known human carcinogen.[xxix]

Parks and Trails

Parks have long been noted for their beneficial effects on mental and physical health.[xviii] One of the most important health impacts of parks and trails is their link to reduced obesity rates, particularly in children. According to the Centers for Disease Control (CDC), two out of every three Americans are overweight and one in three qualifies as obese.[v] Obesity is defined by the CDC as a body mass index (BMI) of 30 or higher.[v] BMI is a measure of weight and height that provides an indication of body fat and weight categories that may lead to health problems, such as cardiovascular disease, certain types of cancer, and type 2 diabetes[v]. According to the CDC, creating, improving, and promoting places such as parks for physical activity have been shown to result in a 25% increase in the number of local residents exercising a minimum of three times a week. Studies have shown that residents living in close proximity to parks (≤ 1 mile) reported 38% more exercise sessions and were four times more likely to visit the park than residents residing farther away. Additionally, research has shown that social disparities play a role in access to and use of activity-friendly environments. Low income neighborhoods and communities of color, in particular, have been found to have lower access to and use of park facilities.

Trees

Trees have been shown in numerous studies to have health benefits.[xi, xviii, xx] The ability to look out on nature has been linked to reduced anxiety, enhanced mental alertness, and improved cognitive performance.[xi] In a study of hospitalized patients, those with tree views had statistically shorter lengths of stay, needed less pain medication, and gave fewer negative comments about their experience.[xi, xx] In addition, tree-lined sidewalks contribute to health by encouraging physical activity and by promoting a sense of community as people more readily become acquainted with each other.[xx] The impact of trees on health also includes their ability to remove toxics (such as ozone) from the air, ultimately leading to reduced exposure to air toxics. Carbon sequestration by urban trees also reduces greenhouse gas emissions, thereby contributing to a reduction in the chemicals responsible for climate change. Moreover, urban trees lower ambient temperatures by providing shade, thereby helping to reduce the risk of heat-related illness.[i]

What is the community goal?

The community goal is to ensure and improve public health across the Houston region. One facet of this goal is to reduce exposure to unhealthy environments (e.g., poor air quality) and the resultant disease burden on the population of the region. Another facet of this goal is to evaluate the benefits of community resources like trees, parks, and trails, on public health and seek ways to improve access to these beneficial components of the environment.

Sixty-one years ago, in 1948, the World Health Organization (WHO) defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."[xxii] WHO's definition has not been amended or changed since that time. The Houston Department of Health and Human Services has outlined seven priority areas for public health as part of its current strategic plan.[xvi] Environmental health (e.g., air quality) is listed as priority three, with the incidence of chronic disease (e.g., asthma) listed as priority seven. The goal of the strategic plan is "to be a good steward of public resources, to provide services in an efficient and effective manner, and to engage with the community in creating a healthier tomorrow."[xvi]

How can we measure progress?

An adequate measure of progress requires, first, a clear description of the current status of the environment, and subsequently, the quantification of the effects of that environment on health. Measurement is a complex task because it involves a multitude of exposures, both good and bad. Ultimately, progress is defined as an improvement in public health. There is growing concern that certain segments of the Houston population face a disproportionately high risk for health issues related to the environment. Studies have shown that low income and minority populations are often at higher risk for environmentally induced health related problems (e.g. obesity, diabetes).[xxi] With that in mind, it is important to consider local, in addition to global, measures of health within the Houston region.

What is the current situation?

Air Quality

The EPA is the national regulatory body for air quality and sets restrictions on the amount of pollutants allowed into the environment. The EPA assesses the risk of adverse health events from exposure to toxic air pollutants and establishes allowable emission levels that correspond with a range of threshold risks of cancer. The EPA recommends considering exposures for health effects across the range of 1 cancer case per 10,000 people to 1 cancer case per 1 million people. The threshold of 1 cancer case per 1 million people is the most health protective value, indicating the least possible risk to human health from exposures to these air toxics. The range of exposure values for benzene is 14.0 ppb to 0.14 ppb (1 in 10,000 risk to 1 in 1 million risk, respectively). The range of exposure values for *1,3 butadiene* is 1.3 ppb to 0.013 ppb (1 in 10,000 risk to 1 in 1 million risk, respectively).

The Texas Commission on Environmental Quality (TCEQ) is the regulatory body for Texas and collects data on air quality at 76 monitoring stations in our area. TCEQ establishes its own guidance for allowable exposures, called effects screening levels (ESL) The ESL for benzene is 1.4 ppb. The ESL for *1,3-butadiene* is 9.1 ppb.

Ozone

Ozone is one of six "criteria air pollutants"; it is the main ingredient in "smog," which is created from a mixture of volatile organic compounds (VOC), nitrous oxides (NOx), sunlight, and heat. The Clean Air Act, as amended in 1990, requires the EPA to set standards (NAAQS) for pollutants considered harmful to the public and environment. In March 2008, the EPA lowered the 8-hour standard for ozone to 75 parts per billion[x] (ppb). While the Houston region has seen improvement in its air quality, in 2008 the region had 38 days above the current EPA limit of 75ppb.[xxvi] Of these, seven days were labeled Level Red (≥116ppb) and 37 days were considered Level Orange or higher (≥96 ppb). Sixteen days were determined to have levels exceeding the 1997 8-hour ozone standard of 84 ppb.

Benzene

Currently all monitors in the Houston region are below the EPA threshold of 1 cancer case per 10,000 people (14.0 ppb) and below the TCEQ limit for exposure (1.4 ppb) However, all stations with available data for 2008 are above the EPA limit of 1 cancer case per 1,000,000 people (0.14 ppb). *Table 1* shows the reduction in benzene level from 2002 to 2008 and compares the current levels with the most health protective threshold of 1 cancer case per 1 million people (0.14 ppb). The Northwest Harris station saw a 2% increase in benzene emissions over this time period.

Table 1: *Harris County Benzene Levels, 2002 - 2008*

Station Name	Annual Average Benzene level in ppb 2002	Annual Average Benzene level in ppb 2008	Percent Reduction 2002-2008*	Percent Above EPA cancer risk threshold of 0.14 ppb in 2008**
Baytown	0.541	0.454	0.16	0.69
Cesar Chavez	0.541	0.434	0.20	0.68
Channel View	*0.731*	0.627	0.14	0.78
Clinton	0.618	0.409	0.34	0.66
Galena Park	1.390	1.170	0.16	0.88
Houston Aldine	0.556	0.366	0.34	0.62
Houston Bayland Park	0.424	0.271	0.36	0.48
Houston Deer Park #2	0.613	0.554	0.10	0.75
HRM #3 Haden Rd.	0.613	0.395	0.36	0.65
Milby Park	0.636	0.311	0.51	0.55
NW Harris County	0.348	0.356	-0.02	0.61
Shores Acres	1.440	0.587	0.59	0.76

Red indicates less than 75% data return or incomplete sampling.
*Percent reduction calculated as (2002 ppb – 2008 ppb)/2002 ppb.
**Percent above calculated as (2008 ppb – 0.14 ppb)/2008 ppb. 0.14 parts per billion equates to a risk level of 1 cancer case/per million people.

1,3-Butadiene

Currently all monitors in the Houston region are below the EPA threshold of 1 cancer case per 10,000 people (1.3 ppb) and below the TCEQ ESL level of 9.1 ppb. All monitors are currently above the EPA limit of 1 cancer case per 1,000,000 people (0.13 ppb) and 1 cancer case per 100,000 people (0.013 ppb). *Table 2* shows the reduction in *1,3-butadiene* level from 2002 to 2008 and compares the current emission levels with most health protective threshold of 1 cancer case per 1 million people (0.013 ppb). Notably, the station at Shore Acres has seen a 112% increase in emission levels of *1,3-butadiene* from 2002-2008.

Table 2: *Harris County 1,3-Butadiene Levels, 2002-2008.*

Station Name	Annual Average 1,3-Butadiene level in ppb 2002	Annual Average 1,3-Butadiene level in ppb 2008	Percent Reduction 2002-2008*	Percent Above EPA cancer risk threshold of 0.013 ppb in 2008** Delete Column.
Baytown	0.183	*0.146*	0.20	0.91
Channel View	*0.473*	0.266	0.44	0.95
Clinton	*0.409*	*0.260*	0.36	0.95
Galena Park	0.281	0.157	0.44	0.92
Houston Deer Park #2	0.322	*0.180*	0.44	0.93
HRM #3 Haden Rd.	0.281	0.157	0.44	0.92
Shores Acres	0.102	*0.215*	-112.00	0.94

Red indicates less than 75% data return or incomplete sampling.
*Percent reduction calculated as (2002 ppb – 2008 ppb)/2002 ppb.
**Percent above calculated as (2008 ppb – 0.0143 ppb)/2008 ppb. 0.013 parts per billion equates to a risk level of 1 cancer case/per million people.

In 2006, the City of Houston commissioned a study by the University of Texas School of Public Health to assess the health risks from 1,3-butadiene exposure, in a population-based analysis of ambient environmental levels of exposure in relation to the incidence of leukemia and lymphoma in Harris County.[xxxii] The study found a 56% increased risk of acute lymphocytic leukemia among children residing within two miles of the Houston Ship Channel (HSC), compared with children living more than 10 miles away.[xxxii] The study further found that when comparing children living in areas of Harris County with the lowest estimated 1,3-butadiene levels, with children in areas with the highest levels, increased risk of developing leukemia was found.[xxxii] A 40%, 38% and 153% increased risk of developing any type of leukemia, acute lymphocytic leukemia, and acute myeloid leukemia, respectively, were observed, after controlling for confounding variables (e.g., income).[xxxii] Additionally, when the cumulative effects of benzene and 1,3-butadiene were considered together, the EPA's acceptable risk level was exceeded for all locations in the area, with the exception of Danciger and Lake Jackson.[xxxii] Milby Park (see the Park Place case study later in this chapter) had the highest cumulative level of exposure, at approximately $8x10^5$, nearly eight times higher than the EPA's acceptable cancer risk level of 1 cancer case per 1,000,000.[xxxii]

Trees

According to the chapter on trees in this edition of *Counting on Quality of Place*, the region is continuing to lose trees. A recent example of tree loss and its impact on health is Hurricane Ike. That storm resulted in the loss of approximately 40,000 trees, some of which were planted in the aftermath of the hurricane of 1900. The sense of personal loss is palpable. Galveston resident Burke Evans stated in a recent newspaper article that: "When I realized I'd lost my trees, I needed something to cheer me up".[xix] With the recent removal of oak trees killed by Ike in Galveston (*Figure 1a*), several residents were in tears, including Yolanda Moran (*Figure 1b*).[xxiii]

Figure 1: *Trees killed by Hurricane Ike.*

Figure 1[a] Trees killed by Hurricane Ike. **1**[b] Galveston resident Yolanda Moran witnessing removal of the dead trees.

Figure 2: *Park Place Super Neighborhood.*

Parks and Recreation

This report calculates the total park acreage available to Harris County residents, in 2008 as 55,975 acres. Despite Houston's significant amount of park acreage, it appears as though the population is not utilizing these spaces to their full potential. Data from the 2008 Texas Behavioral Risk Factor Surveillance System (BRFSS) showed that 27% of surveyed adults in the Houston area reported that they had not engaged in any leisure time physical activities during the previous month. This rate is slightly lower than in Texas as a whole (29%) and just one percentage point above the national (26%) level. Overall, approximately 53% of the local population did not meet the recommended level of physical activity for 2007. Physical activity has also been shown to vary by income, education, and ethnicity.

Case study: Park Place Super Neighborhood.

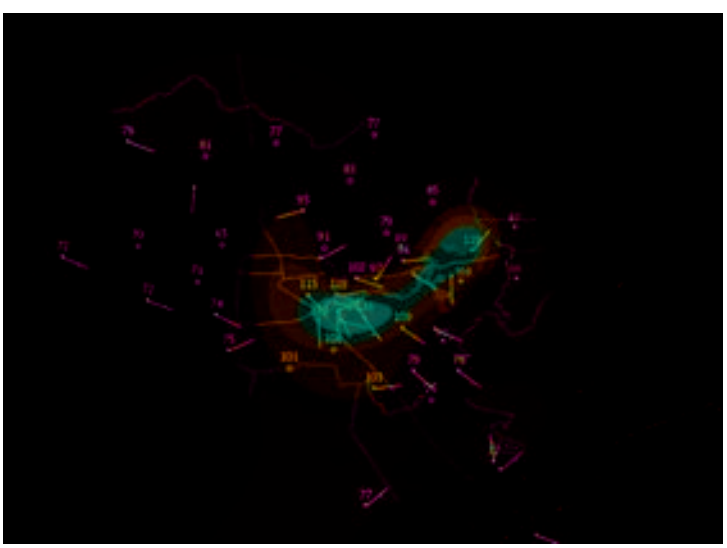
The Park Place Super Neighborhood lies at the union of the Gulf Freeway and Loop 610 (*Figure 2*). Originally incorporated in 1912, it was annexed by the city of Houston in 1927. Park Place was a haven for wealthy Houstonians until WWII, when the burgeoning war industry changed the composition of the population.

By the 2000 census, Park Place had a population of 9,902, of which 73.97% were Hispanic, 26.03% were Anglo, and 10.78% Asian.[vii] Forty percent of the families in the area earned less than $25,000 annually.[vii] Industrialization is concentrated in close proximity to Park Place. The eastern edge of the Super Neighborhood is just over a mile (Euclidean distance) from the Houston Ship Channel (HSC). Six industrial facilities, all emitting toxic chemicals, such as benzene and 1,3-butadiene, are located just east of the neighborhood boundary (*Figure 2*).

Park Place has two local parks, Charles H. Milby and Charlton. One of the largest emitters of 1,3-butadiene is located within four blocks of Charlton Park. This is of particular concern given that local citizens, children in particular, use the park for physical activities, which increase their inhalation and subsequent risk of exposure to toxic chemicals.

Additionally, Park Place Elementary School, with an enrollment of 1,065 students, is located adjacent to Charlton Park (*Figure 2*). The school is situated approximately 1 mile (Euclidean distance) southwest of most of the industrial facilities in the area. A school in such close proximity to the HSC and these major air toxic emitters should be of public health concern. The 2006 study by the University of Texas found a 56% increased risk of acute lymphocytic leukemia among children residing within two miles of the HSC, compared with children living more than 10 miles from the HSC.[xxx] Based on these findings, children residing in the Park Place Super Neighborhood would fall within the highest category of exposure risk.

On October 25, 2008, TCEQ measured the highest ozone levels in the Houston area for the entire year.[xxvii] Park Place 1-hour ozone measurements were greater than 116ppb, shown in red (*Figure 3*). The plume suggested that urban and industrial emissions from the HSC were among the highest ozone levels and the wind direction was coming from that area toward the city (shown in black arrows on the figure).[xxvii]



TCEQ has one monitoring station in the area, named Milby Park (Figures 2, 4), which monitors levels of air toxics. While levels of benzene and 1,3-butadiene emissions at the station have gone down over time (by 51% and 56%, respectively, since 2002), levels of 1,3-butadiene measured at Milby Park are still the highest in the Houston area, according to 2008 TCEQ data.

Figure 4: *Milby Park Monitoring Station.*

In 2008, benzene measured at the Milby Park station was 55% above the EPA threshold of 1 cancer case per 1 million people (0.14 parts per billion (0.311 ppb)). However, compared with other locations in the region, the level of benzene exposure was among the lowest. Both benzene and 1,3-butadiene are associated with cancer, most notably Leukemia and Hodgkins Lymphoma. Children are at particularly high risk from exposure to these chemicals, due to their increased respiratory rates and height.

Emissions of 1,3-butadiene at the Milby Park location for 2008, 0.93 ppb, were more than 3 times higher than the next highest emission level at other area stations (Cesar Chavez, 0.269 ppb). The station recorded 1609 hourly readings with emissions (in the range of 0.92-29.32 ppb). Using the less conservative TCEQ ESL at the 1 in 1 million cancer risk level (0.91 pbb), that equates to 67 days with at least 1 hourly reading outside the acceptable range; 82% of the 1609 hourly readings were above the 1 cancer case per 10,000 people EPA threshold level of risk (1.3 ppb). Hourly readings at a risk level of 1 cancer case per 450 people were observed at the upper range of exposure (29.32 ppb).

Overall, the air quality situation has improved in Park Place and in the greater Houston area. However, there are still considerable risks to human health in localized exposure to toxic chemicals. Moreover, a few years of improved air quality are not enough to mitigate the health impacts from years of exposure to toxic air chemicals. The cumulative effects of exposure, both from multiple chemicals and exposure over time are the drivers of the impacts from air pollution on human health. More detailed studies that consider cumulative exposure effects are necessary to provide a more complete picture of public health in the Houston region.

Where do we go from here?

It is clear that there are several areas of potential concern and promise related to the current state of the environment and health in the greater Houston region. Significant strides have been made, particularly with regard to air quality, but there is much work to be done. Most of the sites are within TCEQ risk threshold. However, many of the region's current monitoring sites are still above the EPA thresholds for acceptable exposure to toxic chemicals. Additionally, a multitude of scientific studies have suggested that for human health protection, the exposure levels should be lower still.

Future research focusing on air toxic exposures in local areas should be undertaken in order to evaluate the effects of air quality on health in the Houston community.. While the positive effects of trees on health have been studied, there currently appear to be no studies quantifying the effects of trees on health within the Houston region. Likewise, it is well known that parks and trails, and associated recreation, make positive contributions to the health of the community; however, quantitative studies of park utilization in relation to health outcomes in Houston are currently lacking. Research focused on park use by Houstonians would shed important light on the overall health picture. In addition, studies exploring the cumulative effects (positive and negative) of the local environment are needed to yield enhanced insight into this overall health picture.

Scientist Conducting Test

Air Quality

APPENDIX A: STRATEGIES FOR REDUCING AIR POLLUTION

Following are some existing strategies for reducing air pollution with a brief explanation of each. These programs reduce nitrous oxides (NOx), volatile organic compounds (VOCs) and air toxics, a subset of VOCs.

- Clean School Bus Program: provides grants to retrofit and replace older diesel engines from school buses. This program reduces NOx and $PM_{2.5}$

- Clean Vehicle Program: provides grants to retrofit and replace older diesel engines. This program reduces NOx and $PM_{2.5}$

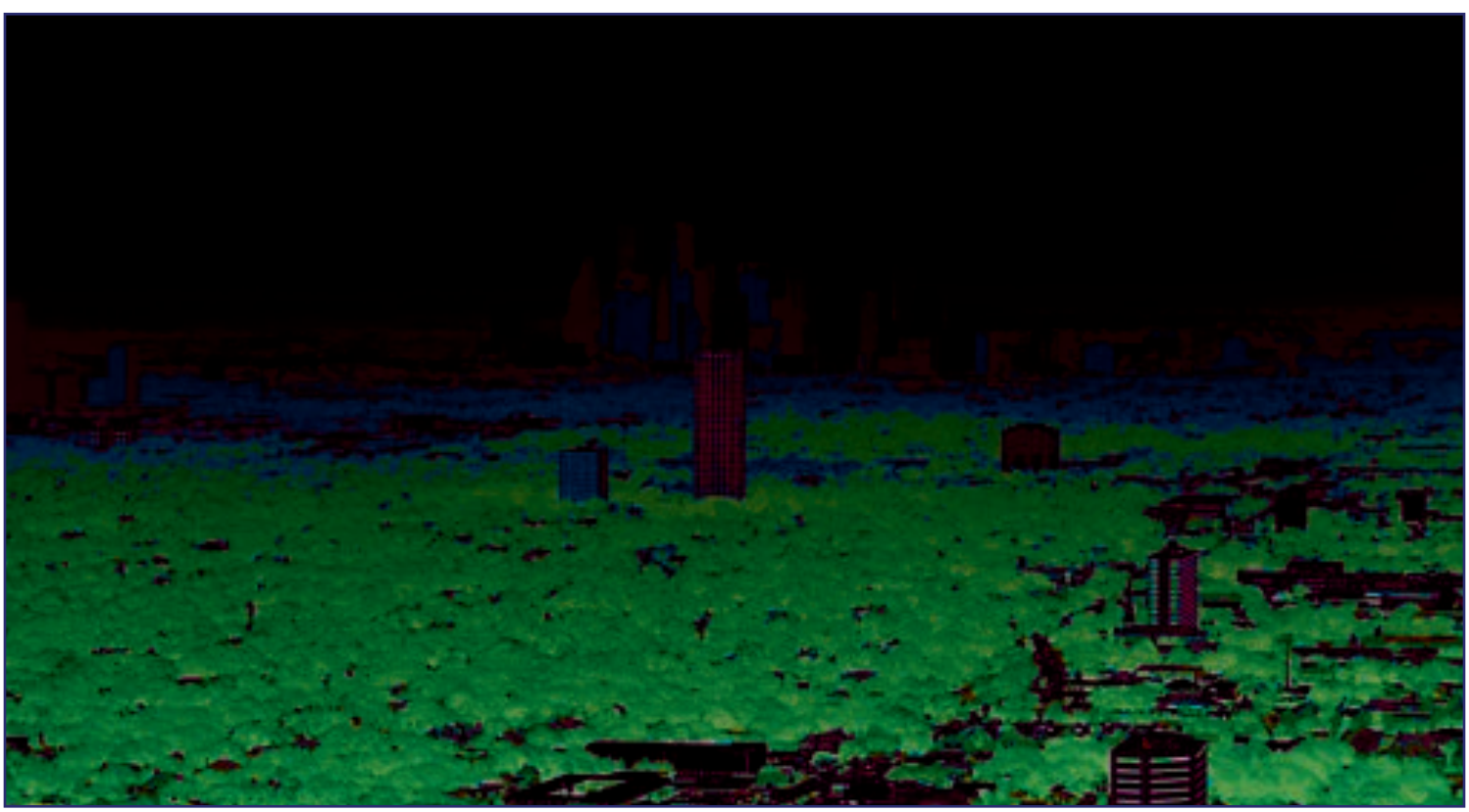
- Clean Cities: promotes alternative fuels and vehicles, fuel blends, increased fuel economy, hybrid vehicles, and idle reduction. This program reduces NOx, VOCs and air toxics (which are a subset of VOCs)

- Commute Solutions Programs: offers a collection of voluntary alternative transportation and trip reduction programs designed to reduce traffic congestion in our roads.

Other programs offered include:

- Carpooling
- Teleworking
- Vanpooling
- Commuter and Transit Services
- Biking and Walking

More information can be found at http://www.h-gac.com/taq/airquality/default.aspx.



Houston, downtown view

i Air Quality Designations and Classifications for the 8-Hour Ozone NAAQS; Early Action Compact Areas with Deferred Effective Dates, 40 C.F.R. Part 81 (2004).
ii Proposed Rule To Implement the Fine Particle NAAQS, 40 C.F.R. Parts 51 and 52 (2005).
iii Id.
iv Id.
v Houston Area Survey, 2009
vi Air Quality Designations and Classifications for the 8-Hour Ozone NAAQS, supra note 1.
vii Id.
viii Id.
ix Id.
x This is because the EPA has set a NAAQS ozone under 42 U.S.C §§ 7408, 7409.
xi Letter from EPA Clean Air Scientific Advisory Comm. to Stephen L. Johnson, Admin'r, U.S. EPA (Oct. 24, 2006). Letter from EPA Clean Air Scientific Advisory Comm. to Stephen L. Johnson, Admin'r, U.S. EPA (Mar. 26, 2007)
xii TCEQ, Fact Sheet: Houston-Galveston-Brazoria SIP (Oct. 1, 2008), available at www.tceq.state.tx.us/assets/public/implementation/air/sip/hgb/HGB_Fact_Sheet_101408.pdf.
xiii NAAQS for Particulate Matter Rule, 40 C.F.R. Part 50 (2006).
xiv Id.
xv Letter from EPA Clean Air Scientific Advisory Comm. to Stephen L. Johnson, Admin'r, U.S. EPA (Sept. 29, 2006)
xvi http://www5.tceq.state.tx.us/tamis/index.cfm?fuseaction=home.welcome
xvii U.S. EPA, Guidelines for MACT Determinations under Section 112(j) Requirements, 1-2, available at www.epa.gov.
xviii Id.
xix U.S. EPA, Toxicological Review of Benzene, In Support of IRIS, CAS No. 71-43-2 (2002).
xx Id.; National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards, Pub. 2005-149 (Sept. 2005).
xxi Id.
xxii http://tceq.com/assets/public/implementation/tox/houstonsfuture/hap.xls

APPENDIX B:

i Harnik, Peter and Ben Welle. 2009 Measuring the Economic Value of a City Park System. Chicago: The Trust for Public Land.

ii GIS disclaimer from Montgomery County Texas Senate Bill 1320-GIS Disclaimer by a governmental agency. Please note that the data that was prepared and/or presented by Montgomery County was not produced using information from an on-the-ground survey conducted by or under the supervision of a registered professional land surveyor.

Please note that Montgomery County does not guarantee the completeness of this information and shall not be liable for any damages suffered as a result of the use of this information

iii Fort Bend County Master Plan 2007 -2012 www.co.fort-bend.tx.us/upload/images/budget_office/comp_plan/VI_parks_recreation.pdf

iv Sugar Land Master Plan 2005 www.sugarlandtx.gov/sugarland/publications/documents/ParksMasterPlan.pdf

v Rosenberg Master Plan 2007 Update. Contact Parks and Recreation Department by phone at 832-595-3960 or by email at: darrenm@ci.rosenberg.tx.us.

vi Harris County Master Plan for Parks, Recreation and Open Space 2003. http://www.eng.hctx.net/parks/parkplan.htm

vii Houston Parks & Recreation Master Plan Update 2007 www.houstontx.gov/parks/pdfs/2007masterplan-final.pdf

viii http://search.census.gov/

ix See Center for Houston's Future report *Counting on Quality of Life: An Environment Indicator Report*. December 2007

APPENDIX C:

i Houston's Regional Forest. Texas Forest Service, September 2005. Online.
http://www.houstonregionalforest.org/Report, p 18.

ii Houston's Regional Forest (2005). Online.

iii Ibid, p. 3.

iv Ibid.

v Ambient air temperature measurements made by HARC staff along north, south, east and west traverses in Houston in support of field studies by Dr. David Sailor, Portland State University, The FUSE Project, 2007.

vi Ibid, p. 13.

vii Ibid.

viii Centerpoint Energy Trees For Efficiency Pilot Project: Impact Analysis Of Shade Trees On Residential Energy Consumption, Houston Advanced Research Center, 2006, 428 kWh savings @ $0.11/kWh, p. 21.

ix City Council Resolution No. 90-3 (adopted January 17, 1990).
http://www.eng.hctx.net/permits/pdf/landscape_regs_info_package.pdf, accessed August 27, 2009.

x Harris County Flood Control District, http://www.hcfcd.org/trees.html

xi Regulations of Harris County for the Approval and Acceptance of Infrastructure and City of Houston Code of Ordinances.

xii See http://www.treesforhouston.org

xiii Tree canopy and tree cover are often used interchangeably, although there can be differences in definitions for data analysis purposes.

xiv Urban Ecosystems Analysis for the Houston Region, American Forests, December 2000.

xv Houston Green – Building Houston's Green Infrastructure, Texas Forest Service, 2002.

xvi Houston's Regional Forest, 2005.

xvii Houston's Regional Forest, pp. 18-19.

xviii NOAA and USGS imagery were compared in this analysis by identifying changes in land cover designations from forest to some non-forest category (on a pixel by pixel basis or a 30 square meter area). Such changes do not necessarily mean an area that was previously defined as forest became urban. Such changes include miscategorization of the land cover as well as differences in land cover definitions between data sources. This method is used here primarily as an indicator rather than a measure of change.

xix Calculation: 89 x 87000=7,743,000 trees; 663.1 million – 7.7 million = 655.4 million trees; 655.4 million trees/7,581 sq. mi = 86,453 trees/sq mi.

xx Ibid, p. 3.

xxi See http://www.treeventure.org for pilot website.

xxii $76.59 per tree average for all planting with both number of trees and expenditures.

xxiii Pickard, Richard G. "TxDOT's Green Ribbon Project", Texas Contractor, an Associated Construction Publications title. April 3, 2006.

xxv HAS Houston Airport System, Newsroom, February 7, 2007, "Houston airports going green."

xxvi All blank spaces are as reported on data sheets; "no response" is reported as as either zero, when known, or not available.

xxvii No funds were allocated to the tree planting 1% fund in 2002-04. Catch up funding was made in 2005. A more representative number or the entire period is $118,231.50 and 975.25 trees per year, the average per year over four years.

xxviii Based on yearly average for period 2004-2006.

xxix 40,000 trees and shrubs, 275 saplings in 2004.

xxx TxDOT reports total tree planting from 2000 to 2008 of 639,594 trees and expenditures of $56,280,055 in the Houston region. This includes plantings in the following counties: Brazoria (4,859 trees/$1,175,806), Ft. Bend (4,515 trees/$2,185,667), Galveston (2,152 trees/$1,901,000, Harris (577,560 trees/$46,328,767) and Montgomery (50,508 trees/$4,688,815).

Tree by riverside - City of Rosenberg

Table 4
Tree Chapter: Appendix C
Types of Trees by County and Tree Size
http://texastreeplanting.tamu.edu/index.html
From Texas Tree Planting Guide: Texas Forest Service, Top Four Trees for Each County

		Brazoria	Chambers	Ft. Bend	Galveston	Harris	Liberty	Montgomery	Waller
LARGE TREES									
American Elm	*Ulmus americana*								X
Baldcypress	*Taxodium distichum*		X			X			
Blackgum	*Nyssa sylvatica*							X	
Bur Oak	*Quercus macrocarpa*	X		X	X				X
Carolina Basswood	*Tilia caroliniana*							X	
Cedar Elm	*Ulmus crassifolia*			X	X				
Green Ash	*Fraxinus pennsylvanica*		X				X		X
Live Oak	*Quercus virginiana*	X	X	X	X	X			
Loblolly Pine	*Pinus taeda*					X			
Pecan	*Carya illinoensis*	X	X	X			X		
Shumard Oak	*Quercus shumardii*								X
Southern Magnolia	*Magnolia grandiflora*	X			X	X	X	X	
Swamp Chestnut Oak	*Quercus michauxii*						X		
White Oak	*Quercus alba*							X	
MEDIUM TREES									
American Holly	*Ilex opaca*	X	X			X	X	X	
Anacua	*Ehretia anacua*			X					X
Carolina Laurelcherry	*Prunus caroliniana*	X							X
Carolina Laurelcherry	*Prunus caroliniana*				X	X			
Eastern Hophornbeam	*Ostrya virginiana*		X				X		
Eastern Redcedar	*Juniperus virginiana*	X		X	X	X		X	
Flowering Dogwood	*Cornus florida*		X				X	X	X
Goldenraintree	*Koelreuteria paniculata*		X				X	X	
Lacebark Elm	*Ulmus parvifolia*	X		X	X	X			X
Texas Sabal Palm	*Sabal texana*				X				
Western Soapberry	*Sapindus drummondii*			X					

Tree Chapter: Appendix

A. Reported Tree Planting: 2000 to 2008
B. Houston Region Municipal Ordinances on Trees
C. Types of Trees by County and Size
D. Information Sources on Trees

Appendix D: Information Sources on Trees

Safety First: For the homeowner and property owners, safety is a key factor on where to plant, avoiding any area where there might possibly be buried utilities or overhead power lines. These need to be considered first before any decision is made on planting locations.

Helpful Houston Area Information Sources on Trees

~ Texas Forest Service Tree Planting Guide
- http://texastreeplanting.tamu.edu

~ City of Houston Tree Guide
- http://www.greenhoustontx.gov/tree.html

~ Trees for Houston
- http://www.treesforhouston.org

~ Houston Area Urban Forestry Council Tree Guide
- http://www.houstonareaurbanforestrycouncil.org/treeguide

~ Houston's Regional Forest
- http://www.houstonregionalforest.org

Table 4
Reported Trees Planting and Expenditures in the Houston Area: 2000 to 2008

	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	
CITY OF HOUSTON											
Parks & Recreation (1% plantings)[i]											
Trees	250	1,212	1,081	28	20	8,595	2,846	34,760	6,441	55,233	Trees
Seedlings	0	0	0	0	0	0	0	0	0	0	Seedlings
Expenditures	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		$
Airport Authority[ii]											
Trees	n/a	n/a	135,000	50	40,275	72	603	20,000	15,000	211,000	Trees
Seedlings	n/a	n/a	0	0	99,000	0	0	0	0	99,000	Seedlings
Expenditures	n/a	n/a	n/a	10,000	n/a	48,300	n/a	n/a	n/a	58,300	$
HARRIS COUNTY											
Precinct 1											
Trees	210	n/a	n/a	n/a	10	90	69	65	59	503	Trees
Seedlings	0	n/a	n/a	n/a	0	0	0	0	0	0	Seedlings
Expenditures	750	n/a	n/a	n/a	750	4,053	7,493	5,149	6,322	24,517	$
Precinct 2											
Trees						195	291	130	185	801	Trees
Seedlings						5,065	30,392	24,328	23,482	83,266	Seedlings
Expenditures						n/a	n/a	n/a	n/a	n/a	$
Precinct 3											
Trees							1,530			1,530	Trees
Seedlings										0	Seedlings
Expenditures										0	$
Precinct 4											
Trees	n/a	n/a	n/a	n/a	n/a	n/a	60	305	240	605	Trees
Seedlings	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	Seedlings
Expenditures	n/a	n/a	n/a	n/a	n/a	n/a	n/a	45,000	35,000	80,000	$
Toll Road Authority											
Trees	n/a	n/a	n/a	3,235	n/a	800	11,888	4,109	0	20,032	Trees
Seedlings	0	0	0	0	0	0	0	0	0	0	Seedlings
Expenditures	n/a	n/a	n/a	411,428	n/a	41,067	1,134,621	585,871	0	2,172,987	$
Flood Control District											
Trees			50	1,500	1,200	7,228	22,167	19,161	19,834	71,140	Trees
Seedlings							2,200			2,200	Seedlings
Expenditures			3,264	97,920	78,336	475,617	1,408,351	1,240,265	1,387,264	4,691,017	$
TEXAS DEPARTMENT OF TRANSPORTATION[iii]											
Trees (partial total)					40,243	67,733	100,211	159,176	94,071	461,434	Trees
Seedlings										0	Seedlings
Expenditures (partial total)					4,522,193	8,128,037	10,181,512	10,541,639	5,550,595	38,923,976	$
HOUSTON-GALVESTON AREA COUNCIL											
Trees							40	110	70	220	Trees
Seedlings										0	Seedlings
Expenditures							2,000	4,000	3,000	9,000	$
HOUSTON METRO											
Trees	1,500	300	300	715	300	300				3,415	Trees
Seedlings							20	20	20	60	Seedlings
Expenditures											$
FORT BEND COUNTY											
Precinct 1[1]											
Trees									10,000	10,000	Trees
Seedlings											Seedlings
Expenditures											$
CITY OF SUGARLAND[ii]											
Trees	124	778	93	120	311	332	80	250	50	2,108	Trees
Seedlings								5,000	10,000	15,000	Seedlings
Expenditures											$
CITY OF ROSENBERG											
Trees									816	816	Trees
Seedlings											Seedlings
Expenditures											
FT. BEND TOLL ROAD AUTHORITY											
Trees					1,468					1,468	Trees
Seedlings											Seedlings
Expenditures											$
PRIVATE SECTOR										0	
Trees for Houston										0	
Trees	2,674	2,797	6,371	7,880	31,660	8,779	7,053	31,872	10,344	109,430	Trees
Seedlings									275	275	Seedlings
Expenditures	383,727	348,783	733,529	413,395	988,578	296,904	358,945	884,354	419,221	4,827,436	$
Neighborwoods											
Trees			100	835	1,075	4,339	1,121	25,138	141	32,749	Trees
Seedlings							21,500		20,200	41,700	Seedlings
Expenditures										0	$
The Park People											
Trees					440	150	85			675	Trees
Seedlings										0	Seedlings
Expenditures										0	$
Keep Sugar Land Beautiful											
Trees								5,000	10,000	15,000	Trees
Seedlings											Seedlings
Expenditures											$
REGIONAL TOTALS	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**		
Trees	4,758	5,087	142,995	14,363	117,002	98,613	148,044	300,046	167,251	998,159	Trees
Seedlings	0	0	0	0	99,000	5,065	54,112	29,348	53,977	241,501	Seedlings
Expenditures	384,477	348,783	736,793	932,743	5,589,857	8,993,978	13,092,922	13,306,278	7,401,402	50,787,233	$

[1] Location of Bates Allen Park; the 10,000 trees were donated from the Apache Foundation.

Source: Center for Houston's Future survey of public and private organizations tree planting activities, 2009.

Houston Region's Municipal Ordinances

The following highlights some of the features of municipal ordinances that affect the trees and urban forest in the Houston region.

City of Sugar Land

The Development Code of Sugar Land, TX required that landscape plans show the location of all Protected Trees, wooded areas, areas with dense shrubbery, and trees and plants to be preserved and those to be removed. Improvements must be designed whenever reasonably possible to preserve a Protected Tree.

The removal of Protected Trees may be approved when it is determined that the development cannot reasonably preserve the Protected Tree, although for each Protected Tree removed two replacement trees of like type must be planted. For each Protected Tree preserved, the owner may receive credit for two trees that would otherwise have to be installed for compliance.

Whenever one or more existing trees, whether protected or otherwise, provides an effective or desirable buffer or screen, the tree may be required to be preserved if the preservation can be accomplished without undue interference with the development of the premises.
http://www.municode.com/resources/gateway.asp?sid=43&pid=13286

City of Conroe

Conroe recognizes that trees add value, and it has an expressed goal of preserving the heritage as an 'urban forest'. A tree inventory and analysis must be performed by an arborist, paid for by the City of Conroe, before any type of under brushing or clearing permit may be requested.

Following the tree inventory and analysis, each residential and commercial developer will decide to replace trees and/or preserve trees. The tree analysis includes a grading system, with highest ranking trees designated as a specimen trees. A drawing of specimen trees will be provided to landowner/developer to be used in development planning.

The tree analysis includes ten factors: condition, type, size, aesthetics, energy conservation and heat abatement, safety, adjacent trees, water quality protection and soil conservation, wildlife habitat, and historic significance.

Every new one and two family dwelling shall plant a minimum of three trees with a caliper of two inches or greater, at least one of these trees must be planted in the front yard. In new parking lots or additional parking lots, one tree of at least six feet initial height must be preserved or planted for each ten additional parking spaces. All new parking lots shall also be buffered from street view by shrubs planted along each perimeter.
http://www.municode.com/resources/gateway.asp?pid=13822&sid=43%20

County of Fort Bend

Subdivision plats that are filed in Fort Bend County shall contain a community of dedicated green space at a ratio of ¼ acre of green space for up to every 100 lots. Green Space is defined as any public or private land that would serve to provide relaxation or recreation to all residents within a specific subdivision.

All development, single family or commercial, either adjacent to or surrounding a Fort Bend County thoroughfare, have regulations regarding Green Space. An additional 10 feet of land on each side of a major thoroughfare right-of-way shall be dedicated as landscape reserves. There shall be a minimum of two 30-gallon trees planted on each side of a major thoroughfare within the landscape reserve for every 100 linear feet of roadway platted.

There shall be a credit given toward the tree requirement for the preservation of any existing tree located within the dedicated land reserve.
http://www.co.fort-bend.tx.us/upload/images/engineering/regs_of_subs/subRegSec7.pdf

County of Montgomery

Montgomery County does not have regulations on tree preservation.
http://www.mctx.org/coatty/ordinances.shtml

The Woodlands/The Woodlands Township

The Woodlands has been a private, unincorporated development for most of its history in which trees and landscaping requirements were part of deed restrictions and community design standards. The Woodlands Township is a recently formed governmental entity approved by the Texas legislature and residents of The Woodlands to take on many of the functions normally associated with municipal government. Landscape and tree protection requirements have always been part of private deed restrictions in The Woodlands, including requirements to maintain native vegetation. For example, front yard landscape is specified as follows: "Forty (40) percent of the Front Yard (excluding the portion covered by driveway and walkways) must be trees, shrubbery, flowers, mulch or plants other than turf or grass. No trees, shrubbery, plants or vegetation may be removed which would result in the grassed area exceeding 60 percent of the Front Yard." Permits are needed for tree removal and trees are protected during construction.
(http://www.thewoodlandsassociations.org/files/standards0206final.pdf)

Likewise, there are private deed restrictions for commercial development that specify protection and inclusion of the urban forest as part of the development. For example: "The forest is the most significant visual natural resource of The Woodlands. The objective of this standard is to recognize, utilize and supplement this natural landscape resource. The concept of the landscape plan should be to retain the character of the native "woodlands." Wherever possible, the existing vegetation should be preserved and utilized. The landscape consists of the trees, plants and groundcover as well as soils that support their growth."
(http://www.thewoodlandsassociations.org/files/CommercialStandards_Web0807.pdf)

City of Rosenberg

Developer of any residential subdivision must set aside and convey to the public sufficient and suitable lands for the purpose of parkland, or contribute cash in lieu of land conveyance, or a combination thereof, as determined by the Planning and Zoning Commission.

There is mention that a site plan must be submitted to the city planner and parks director for review and approval which depends on several factors, including: location, massing and pattern of existing vegetation and the general extent and character of proposed landscaping and tree preservation.
http://library7.municode.com/default-test/home.htm?infobase=19989&doc_action=whatsnew

City of Baytown

Chapter 18 Article XIV of Baytown's ordinances covers landscaping.
http://library7.municode.com/default-test/home.htm?infobase=10022&doc_action=whatsnew

ARTICLE XIV. LANDSCAPING*

Sec. 18-1201. General regulations.

(a) Title. This article shall be known and may be referred to as the "Landscaping Ordinance of the City of Baytown" or simply as the "Landscaping Ordinance."

(b) Purpose. This article is adopted for the purpose of promoting the public health, safety and general welfare of the citizens of the city and is intended to achieve one or more of the following:

(1) To create an aesthetically pleasing environment that improves the quality of life for citizens;

(2) To enhance property values and to protect public and private investment;

(3) To promote the beautification of the city;

(4) To provide adequate light and air space;

(5) To prevent overcrowding of land;

(6) To ensure that the local stock of trees and vegetation is replenished; and/or

(7) To stabilize the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, ground water recharge, storm water runoff, and soil erosion retardation, while at the same time aiding in noise, glare and heat abatement.

Caliper means the diameter of a tree at 18 inches above ground level.

City of Bunker Hill Village

Bunker Hill Village has a Tree Preservation Ordinance in *Chapter 10* Article 17.

APPENDIX D:

Page 1:

a Dr. Highfield is an analytical epidemiologist with training in environmental health risk assessment and spatial analysis of health data. She completed her doctoral training at Texas A&M University, College Station, TX. She is currently the Community Health Information System Manager at St. Luke's Episcopal Heath Charities.

i Bedimo-Rung, A.L., Mowen, A.J., Cohen, D.A. 2005. The Significance of Parks to Physical Activity and Public Health A Conceptual Model. Am J Prev Med 28 (2S2).

ii Burnett, Richard T., Marc Smith-Doiron, Dave Stieb, Mark E. Raizenne, Jeffrey R. Brook, Robert E. Dales, Judy A. Leech, Sabit Cakmak, and Daniel Krewski. 2001. Association between Ozone and Hospitalization for Acute Respiratory Diseases in Children Less than 2 Years of Age. American Journal of Epidemiology, 153(5):444–452.

iii Caputo, A. and Scharrer, G. 2009. Texas air rules violate federal law, EPA says. Accessed: September 18, 2009. Available at: http://www.chron.com/disp/story.mpl/health/6608038.html

iv Centers for Disease Control. Facts about Benzene. Accessed September 30, 2009. Available at: http://www.bt.cdc.gov/agent/benzene/basics/facts.asp

v Centers for Disease Control. Fast Stats. Accessed: September 30, 2009. Available at: http://www.cdc.gov/nchs/fastats/overwt.htm

vi Centers for Disease Control. Physical Activity. Guide to Community Preventive Services Website. Accessed: October 7, 2009. Available at: http://www.thecommunityguide.org/pa/index.html

vii Center for Houston's Future. Counting on Quality of Life: An Environment Indicator Report. 2007.

viii City of Houston. Census 2000: Family income in 1999. City of Houston by Super Neighborhood. Accessed: September 30, 2009. Available at: http://www.houstontx.gov/planning/Demographics/demograph_docs/fam_inc.htm

ix City of Houston. Our Parks. Accessed; September 30, 2009. Available at: http://www.houstontx.gov/parks/ourparks.html

x Environmental Protection Agency. Ozone Air Quality Standards. Accessed: September 30, 2009. Available at: http://www.epa.gov/air/ozonepollution/standards.html

xi Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., Raudensubsh, S. 2003. Relationship between urban sprawl and physical activity, obesity and morbidity. American Journal of Health Promotion. 18,47-57.

xii Ezzati M., Lopez, A.D., Rodgers A., Vander Hoorn, S., Murray, C.J.L., 2002. The Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. The Lancet 360(9343):1347-1360.

xiii Frumkin, H. 2001. Beyond Toxicity Human Health and the Natural Environment. Am J Prev Med 2001;20(3)

xiv Gent, Janeanne F., Elizabeth W. Triche, Theodore R. Holford, Kathleen Belanger, Micheal B. Bracken, William S. Beckett, and Brain P. Leaderer. Association of Low Level Ozone and Fine Particules with Respiratory Symptoms in Children with Asthma. Journal of the American Medical Association, 290(14): 1859-1867.

xv Greater Houston Convention and Visitors Bureau, Houston Descriptions. Accessed September 30, 2009. Available at: http://www.visithoustontexas.com/media/Houston_Descriptions

xvi Hill, J.O., Wyatt, H.R., Reed, G.W., Peters, J.C. 2003. Obesity and the environment: where do we go from here? Science 299(5608):853-855.

xvii Houston Department of Health and Human Services. Charting Houston's Health Houston Department of Health and Human Services Strategic Plan, 2007–2010. Accessed: September 30, 2009. Available at http://www.houstontx.gov/health/StrategicPlanForWeb.pdf

xviii Institute for Health Policy. A Closer Look at Air Pollution in Houston: Identifying Priority Health Risks. Report of the Mayor's Task Force on the Health Effects of Air Pollution. 2006.

xix Jackson, L.E. 2003. The relationship of urban design to human health and condition. Landscape and Urban Planning 64 191–200.

xx Jones, Leigh. Ike spread fruit, flower, vegetable seeds. The Galveston Daily News. Published September 17, 2009. Available at: http://galvestondailynews.com/story.lasso?ewcd=7248558444cc22f1

xxi Kaplan, S., Kaplan, R. 2003. Health, Supportive Environments, and the Reasonable Person Model. American Journal of Public Health. Vol 93, No. 9

xxii Lee, C. 2007. Health Promoting Community Design Environment and Active Living: The Roles of Health Risk and Economic Factors.

xxiii Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.

xxiv Rice, Harvey. First day of tree removal cuts Galveston residents deep. Houston Chronicle. Published July 8, 2009. Available at:
http://www.chron.com/disp/story.mpl/hurricane/ike/6520424.html

xxv Ritz Beate, Fei Yu, Scott Fruin, Guadalupe Chapa, Gary M. Shaw, and John A. Harris. 2002. Ambient Air Pollution and Risk of Birth Defects in Southern California. American Journal of Epidemiology, 155(1):17-25

xxvi Sexton, K., Linder, S.H., Dritana M., Bethel, H. and Lupo, P.J. 2007. Comparative Assessment of Air Pollution-Related Health Risks in Houston. Environmental Health Perspectives: Volume 115, Number 10.

xxvii Robert Wood Johnson Foundation. Designing for active living among adults. Research summary. 2008. Accessed: October 7, 2009. Available at:
http://www.activelivingresearch.org/files/Active_Adults.pdf

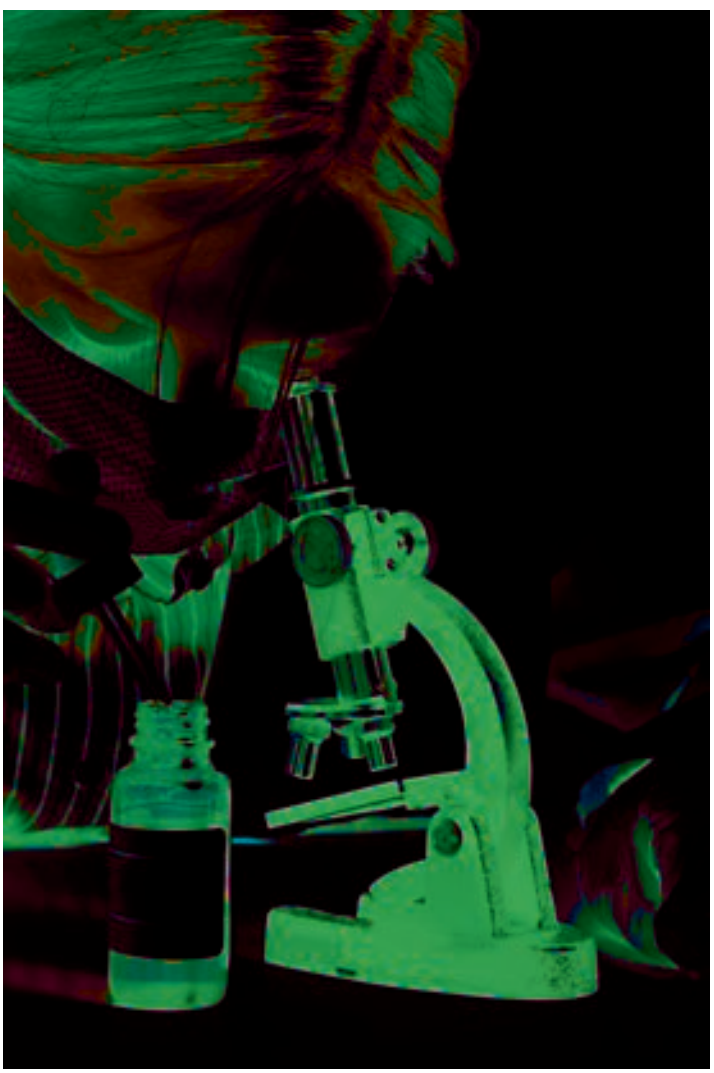
xxviii Texas Commission on Environmental Quality. High Ozone in Your Metro Area. Accessed: October 1, 2009. Available at:
http://www.tceq.state.tx.us/cgi-bin/compliance/monops/ozone_summary.pl

xxix Texas Commission on Environmental Quality. 2008 Air Pollution Events. Accessed: October 1, 2009. Available at:
http://www.tceq.state.tx.us/compliance/monitoring/air/monops/sigevents08.html

xxx U.S. Census Bureau. Houston Quick Facts. Accessed: September 18, 2009. Available at:
http://quickfacts.census.gov/qfd/states/48/4835000.html

xxxi United States Department of Labor, Occupational Health and Safety Administration (OSHA). 1,3-Butadiene health effects. Accessed: October 1, 2009. Available at:
http://www.osha.gov/SLTC/butadiene/healtheffects.html

xxxii Walker, K.M., Coker, A.L., Symanski, E., Lupo, P.J. 2006 An investigation of the association between hazardous air pollutants and lymphohematopoietic cancer risk among residents of Harris County, Texas. Accessed: September 30, 2009. Available at:
http://www.houstontx.gov/health/study.pdf



Testing for Microbes

Acknowledgements

The Center for Houston's Future and its Board of Directors sincerely thank the following individuals who have given so freely of their time to bring the *2009 Counting on Quality of Place: Air Quality, Parks & Trails and Trees* study to a successful conclusion.

Chapter Authors

Air Quality: ***Brigham Daniels***, Assistant Professor,
Holly Reuter, Research Fellow,
University of Houston Law Center

Parks & Trails: ***Ty Ann Noyes***, Adjunct Professor,
Geographic Information Systems, Lone Star College-North Harris

Trees: ***David Hitchcock***, IACP, Director,
Sustainable Transportation, and
Zach Vernon, GIS/RS Research Associate,
HARC

Health: ***Linda Highfield***, Ph.D.
Community Health Information System Manager, St. Luke's Episcopal Health Charities

The Center gives special thanks to Peter Price for his evaluation of our GIS Analysis. Also thanks to Graciela Lubertino (H-GAC) for her assistance with the air quality graphics.

Indicator Steering Committee

Renee Cross, Assistant Director,
University of Houston, Center for Public Policy
Jim Granato,Ph.D., Director,
University of Houston Center for Public Policy
Don Henderson, President
DJH Consulting
Steve Klineberg, Ph.D.
Professor of Sociology, Rice University
Ann Lents, Co-Chair
Quality of Life Coalition
George Martinez, Board Chairman
Center for Houston's Future
Jane Peranteau,Ph.D., Associate Executive Director
St. Luke's Episcopal Health Charities
Bobby Tudor, CEO
Tudor Pickering Holt & Co.
Wil Uecker, Ph.D.,
Professor of Management, Rice University

Air Quality Data Group

Craig Beskid, President,
Mickey Leland National Urban Air Toxics Research Center
Elena Craft, Air Quality Specialist,
Environmental Defense Fund
Alex Cuclis, Research Scientist
Houston Area Research Center
Michael Honeycutt, Ph.D.
Director, Toxicology Division, TCEQ
Lindsey Jones, Toxicology Division, TCEQ
Graciela Lubertino,Ph.D., Chief Air Quality Planner
Houston-Galveston Area Council
Elena Marks, Director of Health and Environmental Policy
City of Houston
Karl Pepple, Ph.D.
Director of Environmental Programming,
City of Houston
Matthew Tejada, Ph.D., Executive Director
GHASP MFCA
Ashley Wadick, Manager
Toxicology Division, Texas Commission on Environmental Quality
Beth Whitehead, Manager of Environment
Greater Houston Partnership
Jayne Willett, Assistant Program Manager
Air and Water Pollution Services, Galveston County Health District

Parks & Tails Data Group

Robert Collins, Special Counsel
Montgomery County Precinct 3
John DeBessonet, Park Planner
Harris County
Diana Foss, Urban Wildlife Biologist
Texas Parks and Wildlife
Renissa Garza Montalvo
Houston Parks and Recreation Department,
City of Houston
Glen Gilmore, City Manager
Richmond, TX
Caterina Gonzalez Cron, Director, Environmental Issues
Harris County Judge Emmett's Office
Peter Harnick, Director
Trust for Public Land
Dennis Johnston, Parks Administrator
Harris County – Precinct 4
D'Neal Krisch, Special Assistant
Office of the County Judge, Fort Bend County
Ann Lents, Co-Chair
Quality of Life Coalition
Darren McCarthy, Parks and Recreation Director
Rosenberg, TX
Chris Nunes, Parks and Recreation Director
The Woodlands, TX
Roksan Okan-Vick, Executive Director
Houston Parks Board
Corliss O'Shaughnessy, Director
Montgomery County Parks
Rachel Powers, Senior Environmental Planner
Houston-Galveston Area Council
Robert Rayburn, Director of Natural Resources
The Energy Corridor
Mike Riggens, Parks Director
Conroe, TX
Kimberly Terrell, Parks Development Manager
Sugarland, TX
Joe Turner, Director of Parks & Recreation Department
Houston, TX
Ike Watkins, Jr., Staff Director
Fort Bend County Precinct 2
Ron Welch, Ph.D., Director of Data Management
University of Houston Institute for
Regional Forecasting
Ben Welle, Assistant Director
Trust for Public Land
Carla Wyatt, Ph.D., Environmental Liaison
Harris County Infrastructure

Trees Data Group

Victor Cordova, City Forester
Houston, TX
Dana Cote, Project Manager
Texas Department of Transportation
Caterina Gonzalez-Cron, Director, Environmental Issues
Harris County Judge Emmett's Office
Deborah January-Bevers, Executive Director
Quality of Life Coaliton
Dennis Johnston, Parks Administrator
Harris County Precinct 4
Sarah Mason, Environmental Analyst
City of Houston
Mickey Merritt, Urban Forestry Coordinator
Texas Forest Service
Chavonne Slovak, Engineering Coordinator
Harris County Precinct 1
Sandra Strachan, Manager, Quality of Life
Greater Houston Partnership
Jeff Taebel, Director of Community &
Environmental Planning
Houston-Galveston Area Council
Barry Ward, Executive Director
Trees for Houston
Ike Watkins, Staff Director
FBC PC2
John Watson, Assistant Manager Facilities Department
Harris County Flood Control District
Chuck Wemple, Program Manager, Community &
Environmental Planning
Houston-Galveston Area Council