RICE UNIVERSITY
**Shell Center for
Sustainability**

HOUSTON
SUSTAINABLE DEVELOPMENT *INDICATORS:*
A Comprehensive Development Review for
Citizens, Analysts and Decision Makers

LESTER KING

RICE

Houston Sustainable Development Indicators:

A Comprehensive Development Review for Citizens, Analysts and Decision Makers

by

Lester King, PhD, AICP, LEED

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John is the Academic Director for the Shell Center for Sustainability and the Maurice Ewing Professor of Oceanography in the Department of Earth Science at Rice University. John has conducted research on various aspects of Antarctic marine geology. He has participated in 24 scientific expeditions to Antarctica. The culmination of this research was published in "Antarctic Marine Geology" by Cambridge University Press. Anderson's other research has focused on the evolution of the northern Gulf of Mexico Basin and the response of coastal systems to global change. His most recent book is entitled "The Formation and Future of the Upper Texas Coast" and he recently co-edited a Geological Society of America Special Paper entitled "Response of Upper Gulf Coast Estuaries to Holocene Climate Change and Sea-Level Rise." He is a Fellow of the Geological Society of America.

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Lilibeth is the Associate Director of the Shell Center for Sustainability at Rice University since 2007. She manages the research, outreach and education activities of the center working directly with faculty, students, and other organizations and institutions. Previously she was the Houston Bicycle-Pedestrian Coordinator where she oversaw public relations and engineering design of a $100M, 350-mile network, completing the first 15-year plan. She was Technical Communications Specialist for the Houston Airport System's Planning, Design and Construction Division, and managed the Houston Air Quality Program for the City of Houston, where she began her career in the Houston Recycling Division, in 1992.

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Lyn is the Dean of the School of Social Sciences, the Radoslav A. Tsanoff Chair in Public Affairs and Professor of Political Science at Rice University. She taught at the University of Arizona for nineteen years and moved to the University of Illinois at Chicago in 2001 serving as Political Science Department Head for five years. Lyn has been an editor of *Political Research Quarterly*, one of the main regional political science journals and the director of a survey research lab. She has published a variety of articles, books, and book chapters on the American presidency and American elections and is currently working on two books on these topics.

Jim Blackburn, JD

Jim has been an attorney for more than 30 years. He is a partner in Blackburn Carter, P.C., and also a Professor in the Practice of Environmental Law in the Department of Civil and Environmental Engineering at Rice University. Jim serves as Director of the Interdisciplinary Minor in Energy and Water Sustainability at Rice and is a Faculty Associate for the SSPEED Center studying "Lessons Learned from Hurricane Ike". His current caseload includes litigation over the future of the whooping crane on the Texas Coast and opposition to permits needed to enable uranium mining in Goliad County. In 2004, Texas A&M press published his manuscript titled The Book of Texas Bays. In 2009, Blackburn co-authored a compilation of art and poems titled Birds: A Collection of Verse and Vision.

Stephen L. Klineberg, PhD

Steven joined Rice University's Sociology Department in 1972. The recipient of ten major teaching awards, including the George R. Brown Lifetime Award for Excellence in Teaching, he is a faculty associate and divisional advisor at Lovett College. In March 1982, he and his students initiated the annual Houston Area Survey, now in its 29th year of tracking the changes in the demographic patterns, life experiences, attitudes, and beliefs of Harris County residents. Co-author of *The Present of Things Future: Explorations of Time in Human Experience*, Dr. Klineberg has written numerous journal articles and research reports, and appears frequently on radio and television. He is also the founding Co-director of Rice University's "Institute for Urban Research."

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Ronald is a professor emeritus of economics at Rice University and a Rice scholar at the James A. Baker III Institute for Public Policy. His research focuses on economic growth and development and energy economics. Soligo was awarded the 2001 Best Paper Prize from the International Association for Energy Economics for his co-authored paper with Kenneth B. Medlock III, "Economic Development and End-Use Energy Demand" (Energy Journal, April 2001). Other recently published articles include "State-Backed Financing in Oil and Gas Projects," with Amy Myers Jaffe in "Global Energy Governance: The New Rules of the Game," eds. Andreas Goldthau and Jan Martin Witte (Brookings Press, 2010); "Market Structure in the New Gas Economy: Is Cartelization Possible?" with Amy Myers Jaffe in "Natural Gas and Geopolitics: From 1970 to 2040" (Oxford University Press, 2006).

Executive Summary

In order for citizens, analysts and elected officials to successfully pursue the sustainable development of the City of Houston, a robust set of indicators are needed. Indicators are needed to identify those issues that are integral to sustainable development, and measure progress of those systems. Sustainable Development indicators, by definition, are distinct from traditional performance metrics in that they are value laden with sustainability principles and themes and a growing sustainability knowledge base.

Sustainability principles and themes include: ensuring balance among the pillars of sustainability (social, economic and environmental awareness); comprehensiveness; reliability and validity, timeliness and sensitivity. The interconnectedness of the various systems of city development is also an important principle of sustainability. Many city departments today enhanced their erstwhile reporting instruments by including reference to sustainability and focusing on such accomplishments as energy savings. While energy savings is indeed important, it is but one cog in the comprehensive sustainable development of a place where people live and work. In fact it can be stated that the pursuit of energy savings should be business as usual for efficient company, organization or city management and hence does not validate the need for sustainable development. Further, most companies that pursue energy savings, do so for the monetary savings and not the environmental or social impact of energy production and consumption.

This document is intended to facilitate discussion and decision making for the Sustainable Development of the City of Houston. The City of Houston municipal boundary was used for most of the metrics in the study. Some indicators like *Air Pollution* or *Water Resources* are regionally generated and have regional impacts, however it is important to understand how the City of Houston is affected.

In general cities are classified with their regions based on some major dependency. For example, people may live in the suburbs and work in the city or people in the suburb may have to pass through the city to get to other suburban destinations. The interdependency of natural resources as outlined in the preceding paragraph is also commonly understood. In the event that the suburbs become less dependent on the central city, then it becomes prudent to ensure that characterization and performance of the city, exclusive of the suburb is conducted. This is because analyses of the region would no longer properly represent the true nature of the city.

The data and cultural climate shows that the City of Houston is losing economic and social prominence in the region and hence regional analyses for many social and economic indicators may not be valid. For example the 2010 Decennial Census shows that the Houston region, Harris County and the City of Houston are growing in population numbers. However, at the city level and county level the White population cohort has been declining over the past 30 years of this study. An environmental indicator such as *Water Demand* also highlights a local versus regional issue. The City of Houston provides water to regional consumers and this is captured in state and national reports as the total amount of water demand for the City of Houston. This becomes even more problematic when per capita estimates are generated for water use, since many published studies use the population in the City of Houston only; or population projections of the City of Houston based on regional growth estimates. Many public agencies

utilize the regional growth forecast for the City of Houston, which was overestimated by at least 500,000 people for the 2010 estimate.

This document discusses several of the issues, important for the sustainable development of Houston. It is organized by first outlining the big issues and topics relevant to the city by presenting them as Themes and Sub-Themes; then selecting indicators to define those themes; then identifying metrics to measure those indicators; then describing the metrics. Policy and programmatic recommendations to improve the indicators of sustainable development in Houston are included after each section. These recommendations are the result of three workshops convened on the campus of Rice University with experts and advocacy groups representing several different fields and agencies in Houston.

The study is primarily intended to assist citizens, staff analysts, and decision makers to understand the answer to the question, *'How are we developing with regards to sustainability in Houston?'*

This document is a follow up to *Measuring City Sustainability: Project Houston* by Jim Blackburn (2010). That document, the first in this series published by the Shell Center for Sustainability, was based on a class review and selection of the most cited indicators of city sustainability in the country in 2010. The present document is an expansion of that work based on: allocation of Indicators according to the *Theme – Sub-theme* framework; systematic structure of indicators to achieve balance among the three pillars in sustainability; data collection for 1990, 2000, and 2010; data collection for indicators not measured in the previous study; and inclusion of methodological sheets for further study. The next document in this series will be a manuscript on neighborhood comparisons in Houston, the expected publication date is Spring 2013.

The following summary is a quick reference guide to data analyzed for each Sustainability Indicator in this report. Green icons indicate good trends towards sustainability. Amber icons indicate moderate trends towards sustainability and some intervention needed. Red icons indicate poor trends towards sustainability and major intervention needed.

	1. **Population Growth**	**1.42% - per year population increase** Population in Houston is growing at an average annual rate of approximately 1.42%.
	2. **Education Attainment**	**74.3% - Completion Rate** There continues to exist an attainment gap between the White Student cohort and other student groups, but in general all graduation rates have improved. However, the Houston Independent School District (HISD) graduation rate was only 74.3% in 2010.
	3. **Voter Participation**	**7% - Voting** Only 7% of the population voted in the local election of 2011. This was the lowest participation rate in 14 years and reflects a decreasing trend in citizen participation.
	4. **Income Inequality**	**13.51% - Ratio of top 20% to bottom 20%** Income inequality has reduced since 2000, but is still higher than in 1990. Between 1990, 2000 and 2010, income inequality changed from 13.01% to 16.76% to 13.51% respectively.
	5. **Poverty Rate**	**23% - Below poverty level** The percentage of persons below poverty was 19% in 2000. This metric is increasing, which is not a sustainable trend. In 2010, 23% of the population was below the poverty level which accounts for 474,346 persons.
	6. **Health Coverage**	**28% - Uninsured** Thirty one percent of persons are uninsured in Houston as of the 2010 Decennial census. In 2000, Harris County had 20% of people uninsured, which increased to 28% in 2010.

	7. Affordability	**30% - Spend more than 30% income on housing** Thirty percent of Houstonians spent more than 30% of their income on housing in 2010. This number was up from 20% in 2000. Since housing in Houston is cheaper than in other parts of the country, this problem may be a result of unemployment or underemployment.
	8. Accessibility of Public Spaces	**44% - Lives within ¼ mile to park** Forty four percent of the population lives within a quarter mile of a public park, which increased from 25% in 2000. This number needs to increase to support a livability agenda.
	9. Food Deserts	**36% - Lives in food desert** Thirty six percent of Houstonians live more than 1 mile from a grocery store or supermarket selling fresh fruit and vegetables. This percentage decreased from 56% in 2000.
	10. Employment Status	**10% - Unemployment rate** The unemployment rate in Houston increased from 7.5% in 2000 to 10% in 2010. For the White cohort it was 6.2% and for African Americans it was 16.5% in 2010. This points to gravely disproportionate hiring and/or employment stability being practiced in Houston.
	11. Primary Jobs and Green Jobs	**23% - Primary Jobs. Less than 7% green jobs** Medical jobs in Houston are increasing as an absolute percentage of total jobs while industrial jobs are decreasing as an absolute percentage of all jobs. Together, health sector and manufacturing jobs make up 23% of all jobs and are considered the primary jobs for Houston in this report. Less than 7% of all jobs in Houston are green jobs.
	12. Income	**$44,001 - Per capita income** Since per capita income in 2010 ($44,001), was a little below 2007 levels ($44,872), we can estimate that the crash in the economy in 2008 set us back approximately 3 years.

	13. Waste Generation	## 7 lbs/person/day - Waste generation The total disposal tonnage for all counties in the Houston region dropped between 2000 and 2010. Additionally the disposal rate per person dropped from 9 to 7 lbs/person/day between those same years. It is not clear if this trend is the result of waste reduction, recycling or reuse practices.
	14. Energy Consumption	## 14,221 kwh - Per household/ year Average residential energy consumption per household increased between 2000 and 2010 from 13,496 kwh to 14,221 kwh. This accounts for 11 million Mwh needed to power Houston homes in 2010. The city administration uses 10% of this energy and HISD uses 4%.
	15. Access to Public Transportation	## 68.5% - Live ¼ mile to transit stop As of 2010, 68.5% of people in Houston live within a quarter of a mile to a bus stop.
	16. Vehicle Miles Travelled	## 8,497 miles/per capita/year - Driving Per capita VMT is projected to increase in Houston. In 2000 8,560 miles was the average per person. In 2010 that average dropped to 8,497 miles per capita. However the average is expected to surpass 10,000 annual miles per person by 2030.
	Travel Choice	## 75% - Drove alone to work A higher percentage of people in Houston were travelling alone in private cars in 2010 than in 2000. In 2000 28% of persons travelled to work alone in private cars. The number dropped to 25% in 2010.
	17. Ambient concentrations of air pollutants	## Not in attainment for Ozone Houston is managing regulated air pollutants under federal standards except for Ozone levels, which has consistently been higher than the federal standards.

	18. Greenhouse Gas Emissions	**Harris County is 2nd Highest CO_2 emitting county in country** Harris County has reduced industrial CO_2 emissions between 2000 and 2008. However, CO_2 emissions from private vehicles are increasing and now constitute the largest source for CO_2 emissions in Harris county.
	19. Water Pollution	**Meets Federal Standards for Drinking Water** The City of Houston publishes annual updates of drinking water quality to all residents and is currently meeting all federal regulations regarding water quality. However, emerging and unregulated contaminants are not accounted for concerning drinking quality and these constitute an unknown risk to consumers.
	20. Water Use	**165 Gallons/person/day – Water consumption** Per capita municipal water use in Houston increased from 159 gallons per day in 2000 to 165 gallons per day in 2010. Unless this trend is reversed, water usage will increase disproportionally with population growth.
	21. Water Availability	**1.8 Billion gallons/day - Access rights** The City of Houston owns access rights to a little less than half of the available water in the region. This was 1,264, 231 acre-feet in 2010. Although this availability was lower than in 2000, the Houston municipal water demand for 2010 was 389,082 acre-feet.
	22. Flooding	**25% - Population in floodplain** One quarter of the city of Houston is at risk of flooding.
	23. Land Cover Change	**46% - Land area is medium to low development** The highest increase in land cover between 2001 and 2006 was for medium intensity development. This was an increase from 150 square miles to 160 square miles. Medium intensity development accounts for the highest land coverage type in Houston and most commonly includes single family housing units

		### 21% - Housing located ¼ mile from job centers
	24. Jobs / Housing Balance	The percentage of jobs and housing close to job centers is increasing, which is good for agglomeration. However only 21% of housing units are located within a quarter mile of the business centers in 2010. This means that 78% of persons are commuting to work, and primarily travelling alone in private autos.

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SOCIAL DEVELOPMENT
PILLAR OF SUSTAINABILITY

LESTER KING

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Social Development Pillar of Sustainability

Theme - Social Demography
Sub Theme - Population Growth

Indicator - Population Growth

Population Growth is one of the indicators of urban successes in the United States (Linneman & Saiz, 2005). Municipalities compete for population growth in different ways: ensuring adequate housing supply; quality schools; or funding beautification projects for an enhanced quality of life (Hill & Brennan, 2012). Some suggest that Houston's population growth is based on its ability to provide an affordable lifestyle for middle-class people, primarily due to low cost housing (Glaeser, 2011). Population growth has an essential impact on sustainability in that the per capita demand on non-renewable resources should be monitored to ensure supplies are available for present and future generations. Houston is the 4th largest city in terms of both population and land area and the 25th most densely populated among the 63 largest cities in the country (U.S. Census Bureau, 2011).

Sustainability Benefit: Houston is attracting new residents, which suggests that these new residents perceive living in Houston as advantageous over other places to live.

Sustainability Issue: More residents require more resources. Sustainable management of natural resources in Houston is critical to ensure that the supplies are sufficient to accommodate the needs of increasing population levels.

The following figures and tables represent different metrics to measure the indicator *Population Growth*:

Figure 1: City of Houston Population Growth
Figure 2: Harris County Population Count
Figure 3: City of Houston Average Annual Growth
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Table 1: Growth comparison of White and Hispanic populations
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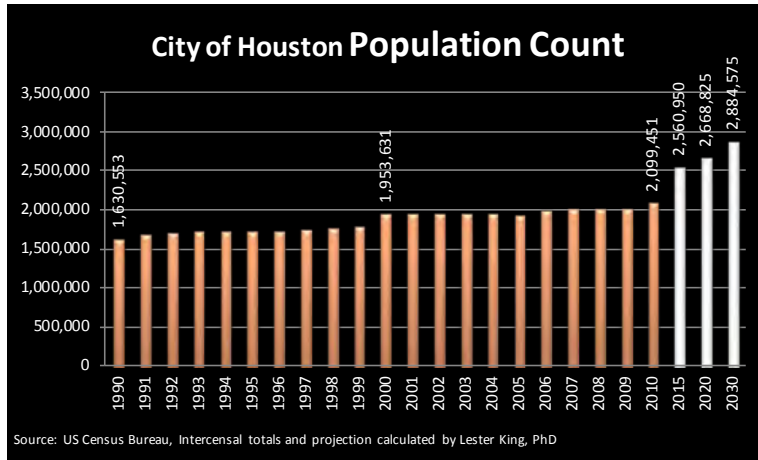
Figure 1: City of Houston Population Growth

- In 2010 Houston is the fourth largest city in the United States with 2,099,451 people (Census 2010).

- Based on the population growth trend between 1990 and 2010, the City of Houston will gain over 500,000 persons by 2020.

- The 2030 population is projected to be 2,884,575 persons within the city limits (Figure 1).
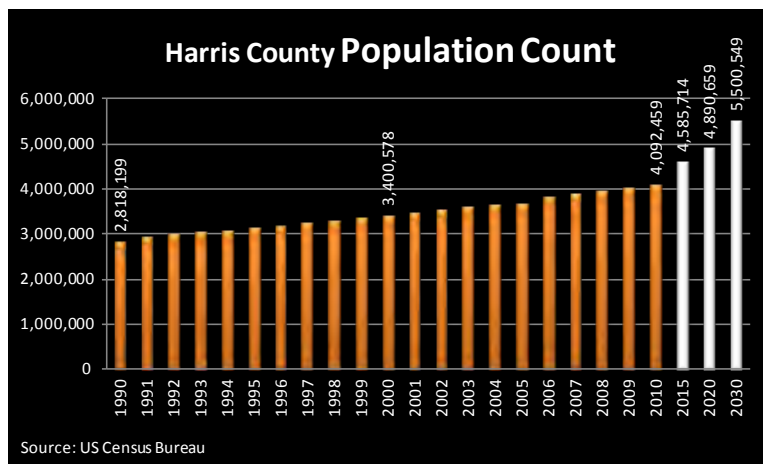
Figure 2: Harris County Population Count

- The City of Houston is located in Harris County, Texas. Harris County is the most populated county in the state of Texas with 4,092,459 persons as of the 2010 Decennial census.

- It is also the third most populous county in the country according to the 2010 census, behind Los Angeles County, CA - 9,818,605 persons; and Cook County, IL - 5,194,675 persons (US Bureau of Census 2011).

- The City of Houston comprises roughly half of the population of Harris County.

- Harris County is projected to add almost 800,000 persons by 2020 and almost 1.5 million persons by 2030. The 2030 population is projected to be 5,500,549 persons (Figure 2).
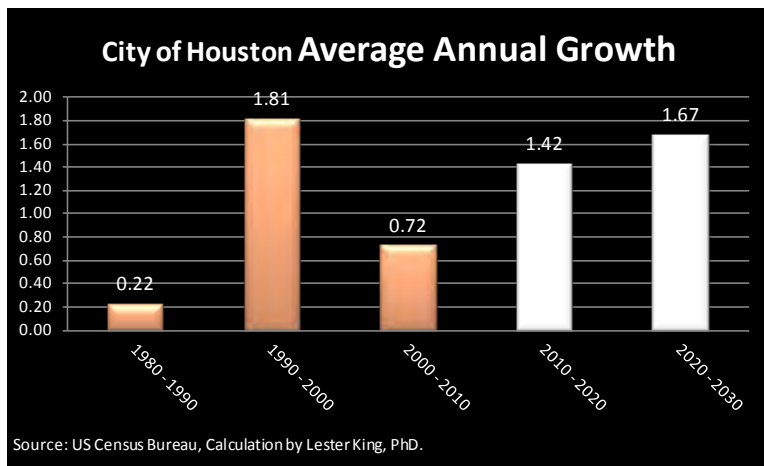
Figure 3: City of Houston Average Annual Growth

- The average annual percentage growth rate in Houston fluctuated between 0.22% per year from 1980 to 1990 and 1.81% per year between 1990 and 2000.

- Based on the linear trend between 1980 and 2010, the average annual percentage rate of growth is not expected to climb above the levels seen between 1990 and 2000 over the next 20 years (Figure 3).
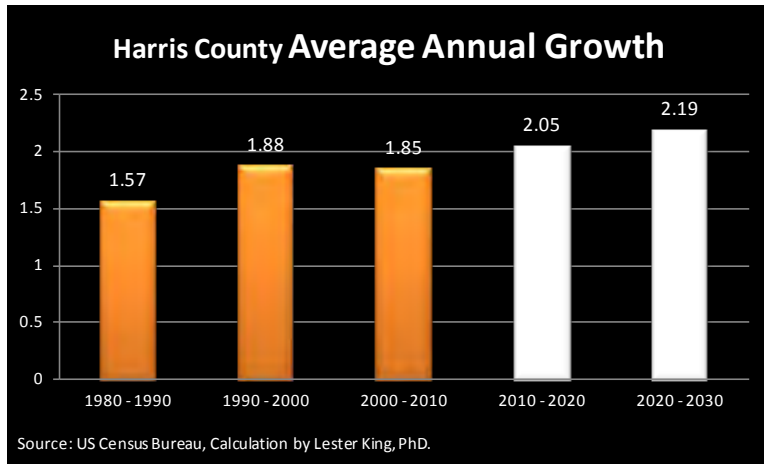
Figure 4: Harris County Average Annual Growth

- Figure 4 shows that the average annual percentage rate of growth is higher in Harris County than it is in Houston.

- Population is increasing in Harris County, in areas outside of Houston, faster than within the city limits of Houston.
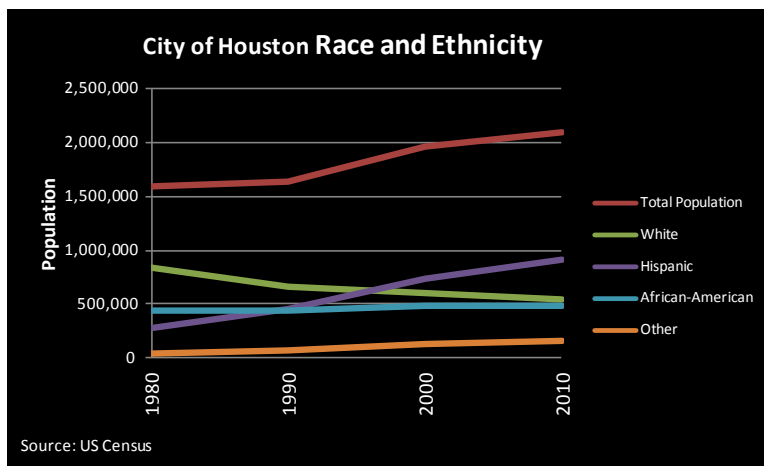
Figure 5: City of Houston Race and Ethnicity

- The race and ethnicity composition of the city is as follows: Hispanic 43.8%, White 25.6%, Black 23.1%, All others 7.4%.

- In 1980 there were at least 500,000 more Whites than Hispanics in the City of Houston. The exact counts were 834,061 White and 281,331 Hispanics.

- The population counts for Whites and Hispanics were approximately the same around 1996.

- The latest decennial census results show that there are almost 400,000 more Hispanics in the City of Houston than Whites. Exact counts are 537,901 Whites and 919,668 Hispanics.

- In 1980, the African American population was almost half that of the White population. In the 2010 census the African American population was estimated at just over 50,000 persons less than the White population.

- The City of Houston is losing population among the White cohort.

- Most of the growth in the City of Houston can be attributed to the Hispanic population. A look at figure 5 shows that the trend for the Hispanic population almost exactly matches the trend for the city as a whole after the 1990 census.
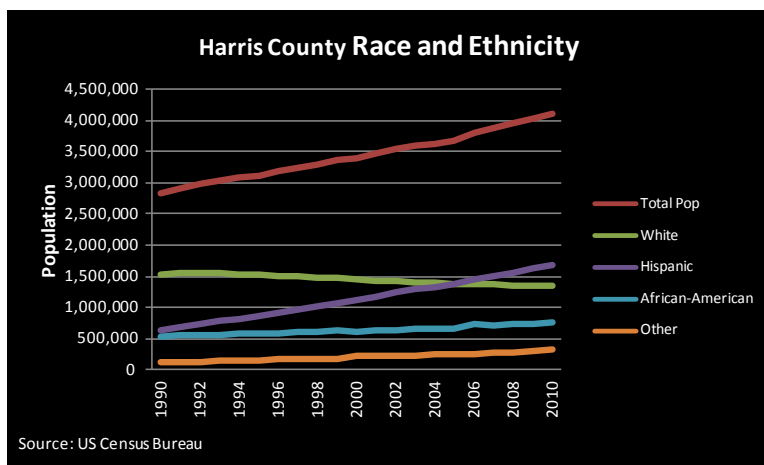
Figure 6: Harris County Race and Ethnicity

- In comparison to the City of Houston, the Hispanic population only overtook the White population after the 2000 census around 2005. However, since the Hispanic population and the total population for the county have similar trends, we can say that most of the growth in Harris County is also attributed to the growth in the Hispanic population.

- The White population in the county is also declining, but the rate is not as steep as in the City of Houston.

- The Hispanic population accounts for the largest population group, both in Harris County (1,671,540 persons, 41%) and the City of Houston (919,668 persons, 44%) (Figure 6).

- The race and ethnicity composition is as follows: Hispanic 40.8%, White 33%, Black 18.4%, All others 7.7%.

	1980	2010	Percentage Average Annual Growth
White COH	834,061	537,901	-1.46
Hispanic COH	281,331	919,668	3.95
White Harris	1,509,430	1,349,646	-0.37
Hispanic Harris	369,077	1,671,540	5.03
Source: US Census, Calculation by Lester King, PHD.			

Table 1: Growth comparison of White and Hispanic populations

- Table 1 compares the average annual percentage growth in the Hispanic and White populations between the City of Houston (COH) and Harris County (Harris). The table shows that Hispanics are increasing in Harris County at a faster rate than in the City of Houston.

- Additionally the White population is decreasing at a slower rate in Harris County than in the City of Houston.

- The results suggest that living in Harris County beyond the City of Houston city limits is more desirable to Hispanics looking for a new home in the region.

- Since the White population is declining, data suggests that whites leaving the area are more inclined to leave the City of Houston than Harris County.

- Further research into the composition of the population groups would reveal whether those leaving were attributed to deaths or migration or other factors.

City of Houston Population Density

Year	Density
1990	2,903
2000	3,237
2010	3,346
2015	4,128
2020	4,237
2030	4,440

Source: US Census, City of Houston, Calculation by Lester King, PhD.
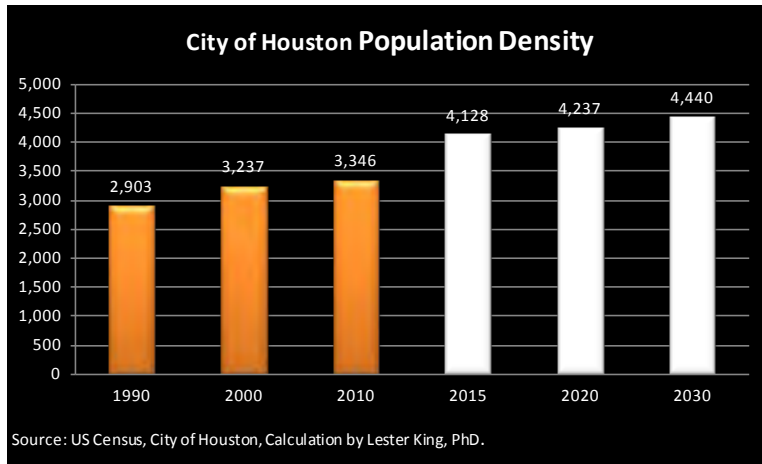
Figure 7: Population Density

- Houston's Extraterritorial Jurisdiction (ETJ) is a five mile area surrounding the city limits. The State of Texas devolves to cities rights and responsibilities to manage property within the city limits and limited rights and responsibilities to property within this ETJ. One of the rights is that of annexation.

- After 1999 the City of Houston has primarily enacted limited annexation of property therefore the size of the city is not expected to increase by a considerable amount over time.

- The population density projection assumes the percentage increase in square miles between 2000 and 2010 would continue; and that the average growth population growth between 1980 and 2010 would continue. By 2030 the density of the City of Houston will increase by 1,094 persons per square mile more than 2010 (Figure 7).
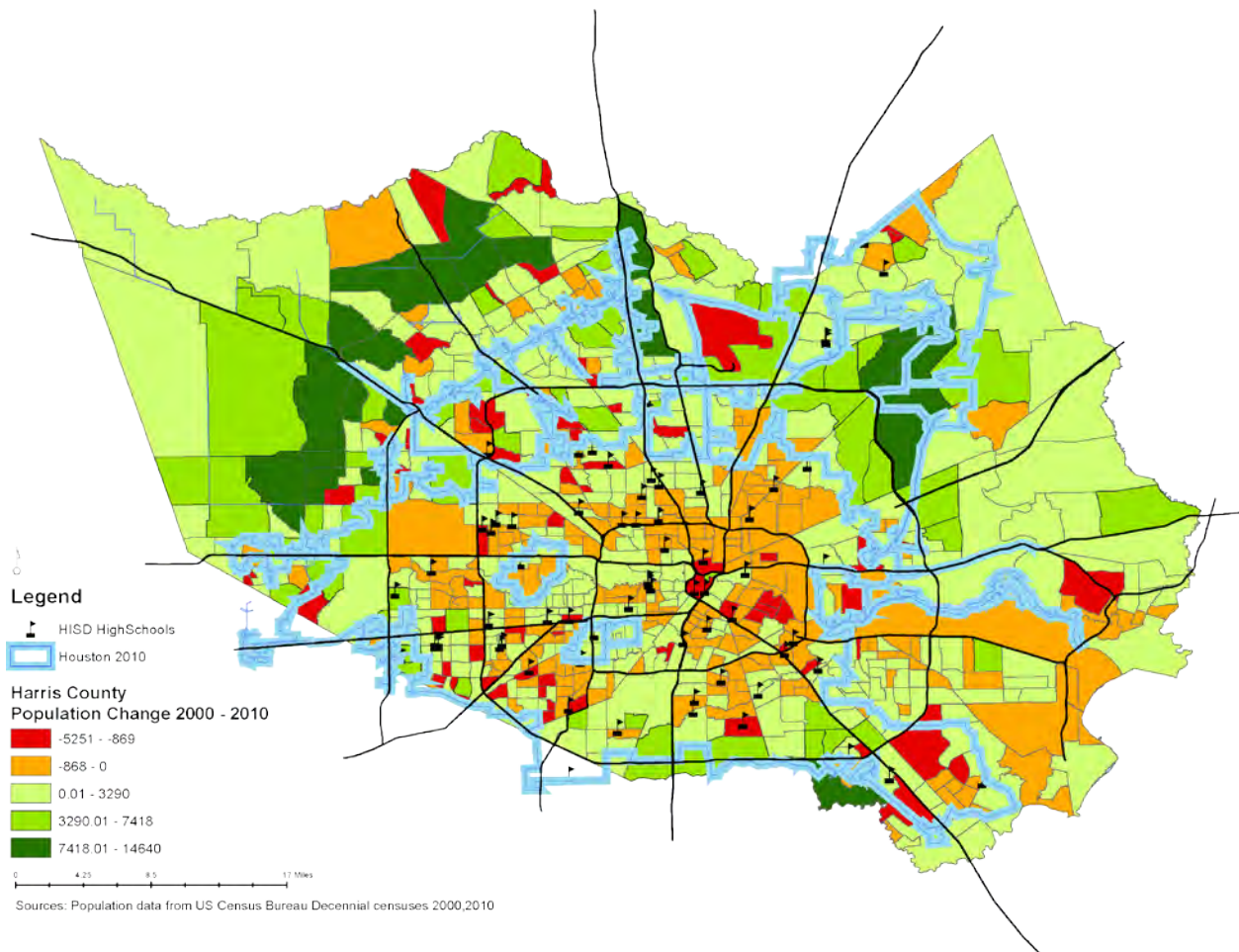
Figure 8: Population Change 2000-2010

- Houston gained 145,820 people between 2000 and 2010. However many areas within the city border actually lost population.

- This is a major problem, since as the map above illustrates, many of these areas losing population correlate with areas where the public high schools are located.
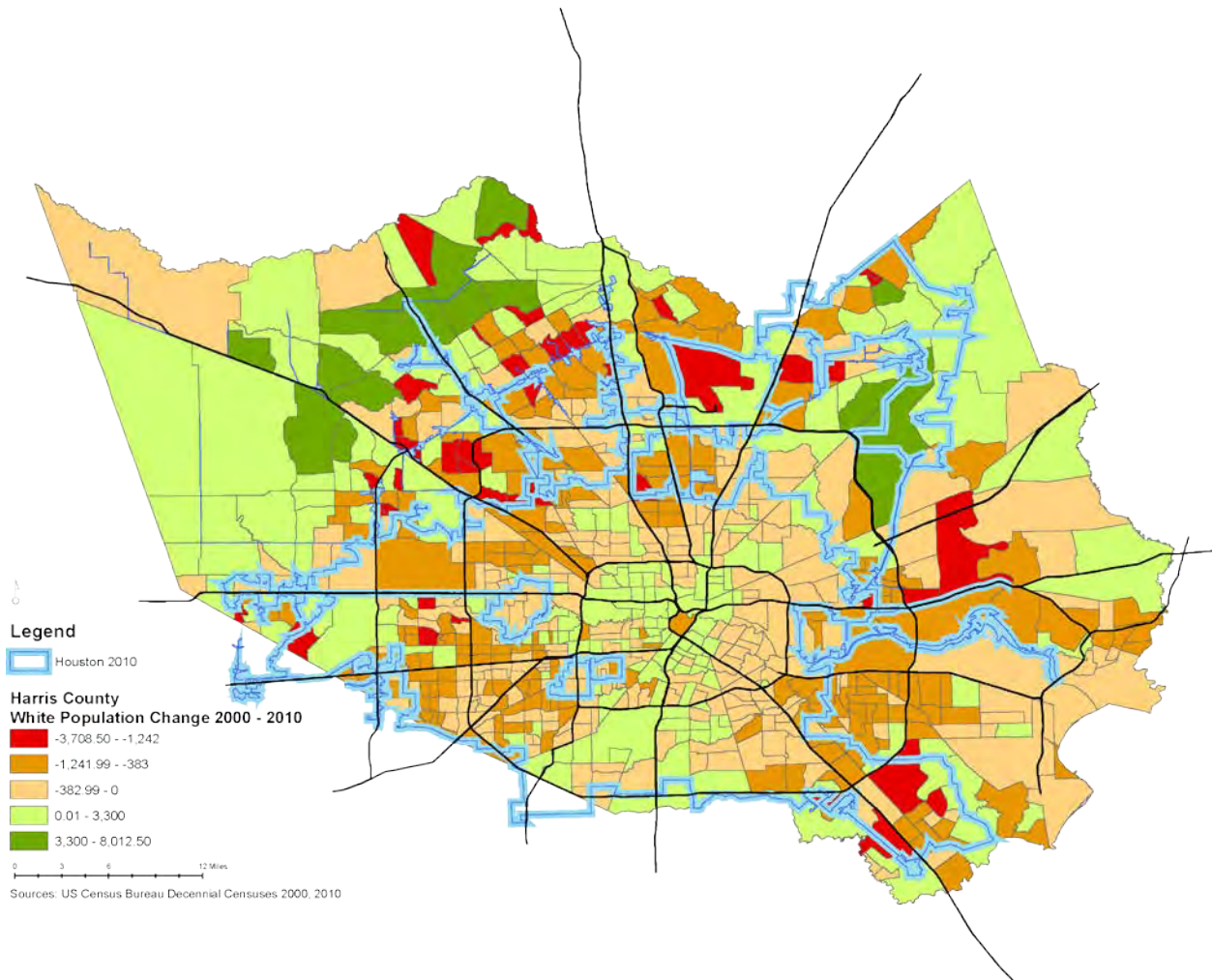
Figure 9: White population change 2000 – 2010

- The City of Houston lost 63,950 persons from the White population between 2000 and 2010.

- The map above shows that the population loses were greater in the central city and the outer edges of the city. Population increase were recorded in the central loop.

Theme - Social Demography

Sub Theme - Education

Indicator - Education Attainment

Critical to economic, civil, and personal health viability is **Education Attainment** (CFH, 2012). Higher levels of education directly produce healthier behaviors such as more exercise and enhanced nutrition; better jobs and income and higher quality neighborhoods; and more resources for healthcare (Sanborn, 2012). According to the 2010 decennial census, 38.7% of persons without a high school diploma were unemployed. Of the 61.3% of persons without a diploma, that were employed, the median earnings was $17,338 in 2010. The median earnings in the City of Houston was $30,241 and the median earnings of persons with a college or associate's degree was $30,313 (US Bureau of Census 2010). This suggests that the average Houstonian has some college or an associates degree. The high school diploma is the fundamental threshold for the achievement of enhanced quality of life. Education is the number one indicator among sustainability indicator studies across the country (Blackburn, 2011).

Sustainability Benefit: The graduation rate for High School is increasing.

Sustainability Issue: There exists a gap between the graduation rates of the White student population and all other groups.

The following metric, *Figure 10: Percentage of Students Graduating High School,* **is used to measure the indicator** *Education Attainment***.**
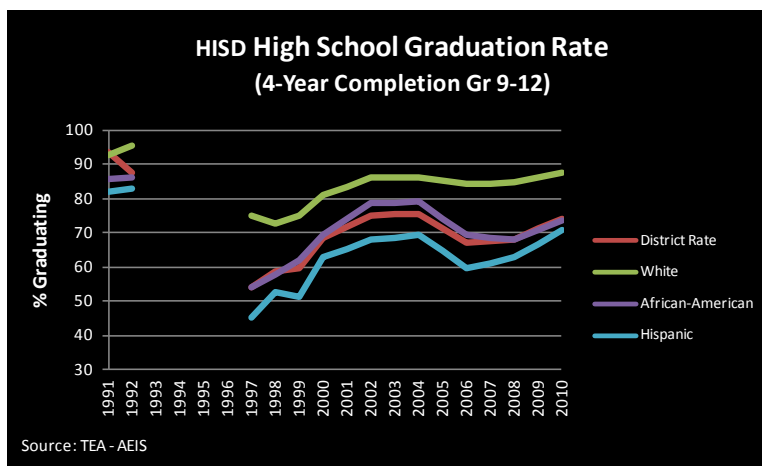
Figure 10: Percentage of Students Graduating High School

- The percentage of persons graduating is rising in the Houston Independent School District (HISD) since 2006, after a short dip from 2004.

- What is also striking about Figure 8 is the gap in graduation rate between White students and all other race and ethnicities. In 2010 the average graduation rate was 74.3%, which was similar to the African-American graduation rate. The Hispanic graduation rate was 70% and the White graduation rate was 87.9% (Figure 8).

- Hispanic students accounted for 62% of the HISD student body in 2010 and African American students accounted for 27% of students. White students only accounted for 8% of the HISD student population (Houston Independent School District, 2010). White students in Houston who do not attend HISD may reside in parts of Houston not within HISD administrative boundaries or attend private schools.

Theme - Social Demography
Sub Theme - Community Involvement

Indicator - Voter Participation

Voter participation is a sign that citizens are involved in their community. Participation leads to a sense of community (Julian, Reischl, Carrick, & Katrenich, 1997). Societies which have higher voter participation also tend to have enhanced livability and high social capital since residents are more involved in the management of their neighborhoods and communities. The State of Texas has empowered local neighborhoods with enforcement capabilities called 'Deed Restrictions', to allow citizens to develop and enforce their own neighborhood building and design standards. This is an excellent model for the empowerment of citizens and their sense of local neighborhood (Julian, Reischl, Carrick, & Katrenich, 1997). As a result, arguably, residents have focused their limited time and attention on the administration of neighborhood needs and devolved management of the city commons, outside of neighborhoods, to elected officials. An increase in voter participation is a good indicator demonstrating the degree of public interest with the comprehensive management of the City of Houston.

Sustainability Benefit: Voting in Houston is conducted in a democratic format.

Sustainability Issue: Very few people vote in the local elections.

The following metric, Voter Participation in Houston, is used to measure the indicator *Voter Participation.*

Source: Harris County Clerk, US Census, Calculation by Lester King, PhD.
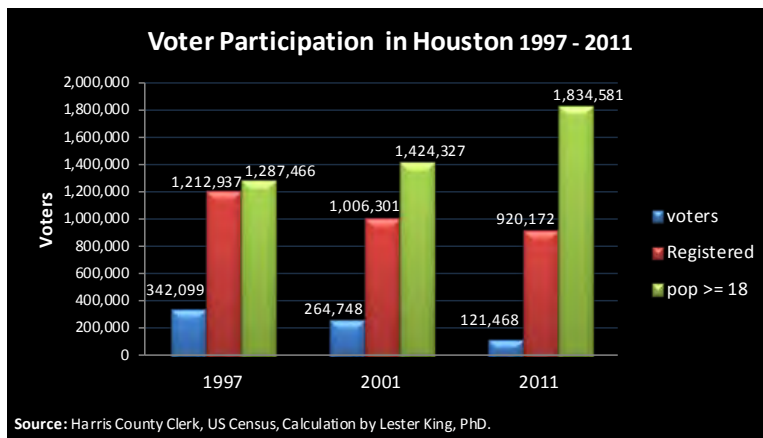
Figure 11: Voter Participation in Houston

- Only 7% of the Houston voting age population voted in the local election of 2011. This was the lowest voter participation rate in comparison to 1997 and 2001. The number of people who voted also constituted 13% of the registered voters.

- In 1997, 27% of the voting age population and 28% of the registered voters participated in local elections.

- In 2001, 19% of the voting age population and 26% of the registered voters participated in local elections.

- The figure shows that over the last 14 years as the population in Houston increased less persons registered to vote and less persons actually voted, which indicates a decrease in social capital.

Theme - Poverty
Sub Theme - Inequality

Indicator – Income Inequality

Income inequality has an effect in the broad social capital of a city since it gives rise to separate cultures of poverty. Persons in poverty are unable to prioritize spending on maintenance of physical living spaces, which leads to blighted neighborhoods. They are unable to contribute properly to the tax base, which makes it more difficult for public agencies to supply public services. Income disparities are greater today than at any other time since the 1920s in Harris County and greater in America than in any other country (Klineberg, 2005)

Sustainability Benefit: Median household income earnings in Houston have increased over time.

Sustainability Issue: The top 20 percent of earners report fluctuating incomes.

The following metrics are used to measure the indicator *Income Inequality*:
Figure 12: Median Income Comparison
Figure 13: Ratio of Share in Income
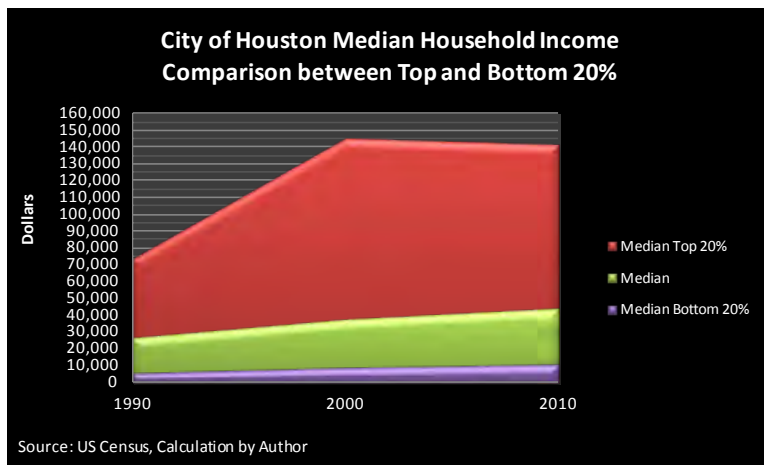
Figure 12: Median Income Comparison

- Figure 12 shows that the top 20 percent of wage earners increased at a much faster rate between 1990 and 2000 and then dropped between 2000 and 2010. This steep increase between 1990 and 2010 was not reflective in the median income of the city as a whole is indicative of income disparity in the city.

- The top 20 percent median household earnings dropped between 2000 and 2010 but this drop did not have a noticeable impact on the median income in the city. This suggests an income disparity between the top 20 percentile and the rest of workers.

- The median household earnings of the top 20 percentile was approximately $140,000 in 2010. The median household income in the City of Houston was approximately $43,000 and the median household income of the bottom 20 percentile was approximately $10,000.

**Ratio of Share in Income
Between the Top and Bottom 20%**

Source: US Census Bureau, Calculation by Lester King, PhD.
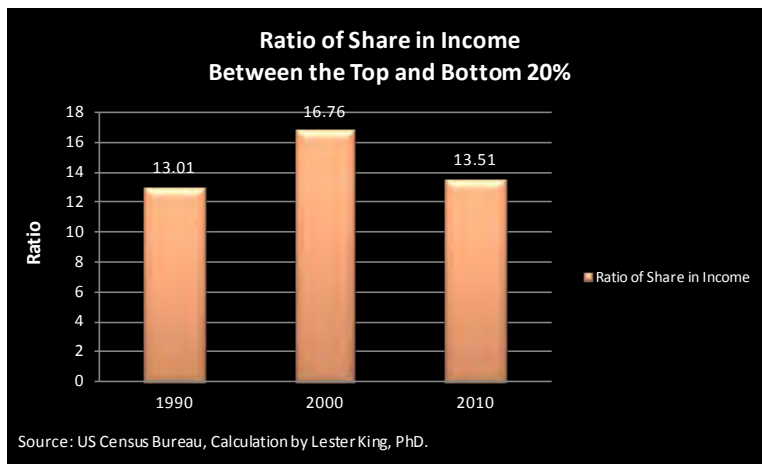
Figure 13: Ratio of Share in Income

- The ratio between the top 20th percentile and the lowest 20th percentile shows the degree to which these two groups trend together over time.

- In 2000 the income disparity increased to 16.76 points, up from 13.01 points in 1990. That number is now 13.51 in 2010.

Theme - Poverty
Sub Theme - Poverty Level

Indicator – Poverty Rate

High **Poverty rates** lead to development of social cultures, which by necessity favor private survival needs over involvement in public affairs. This suggests that public features, such as schools, parks, sidewalks, streets and neighborhood businesses, will suffer from neglect due to pervasive poverty. Reduction in poverty rates is important because it helps households become self sufficient. Access to good jobs, good schools, and shopping does not occur in poor neighborhoods (McClure, 2008).

Sustainability Benefit: The drop in poverty rates between 1990 and 2000 compared to the sharp increase in income between 1990 and 2000 shows that the local economy is capable of lifting persons out of poverty.

Sustainability Issue: The poverty rate in 2010 was higher than it was in 1990 and 2000.

The following metric, Figure 14: Population Living Below Poverty, is used to measure the indicator *Poverty Rate*.
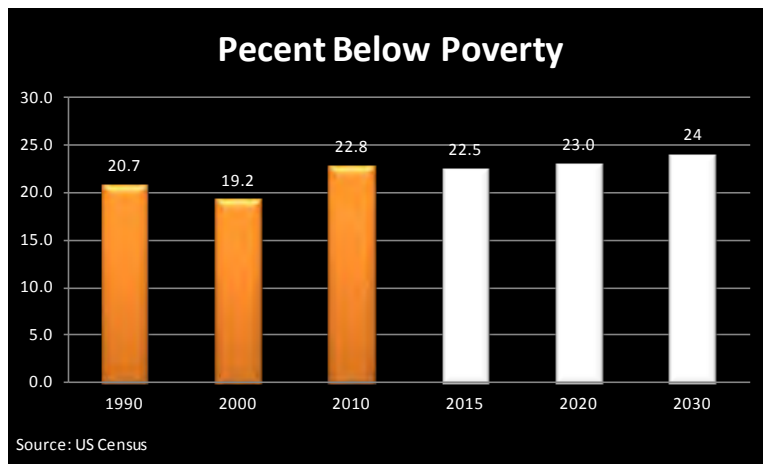
Figure 14: Population Living Below Poverty

- Data gathered between 2006 and 2010, shows that the percentage of persons below the poverty line was higher in Houston (23%) than it was in Harris County and Texas (16.8% for both). The percent of people below the poverty line in the United States was 13.8% (US Census Bureau, 2010).

- In 1990 one fifth of all Houstonians were living in poverty and by 2015 another 2 percent of Houstonians will be living in poverty as predicted in Figure 11.

- Based on the current trend the City of Houston is expected to have almost 25% of people living below the poverty line by 2030.

Theme - Poverty
Sub Theme - Healthcare Delivery

Indicator – Health Coverage

Health coverage is essential in this country to access quality care. In measuring access to healthcare, one can measure the physical access such as the distance and difficulty to get from home or work to a healthcare institution. However, in the U.S., there is a major barrier to access, which is the need to have healthcare insurance before adequate care can be offered. The provision of healthcare is normally offered by employers to employees in the U.S. and as a result persons without jobs are vulnerable to not having access to healthcare. In 2010, the Affordable Care Act was signed into law to improve the delivery of affordable health care services (Office of the Legislative Counsel, 2010).

Sustainability Benefit: The Texas Medical Center in Houston is the largest medical center in the world.

Sustainability Issue: The percentage of persons without health insurance has increased in Harris County.

The following metric, Table 2: City and County Health Insurance Estimates, is used to measure the indicator *Health Coverage*.

	2000 Harris (a)	2010 Harris (b)	2010 Houston (b)
Insured	2,754,239	2,946,305	1,445,921
Uninsured	676,637	1,141,788	646,313
%	19.7%	27.9%	30.9%
Source: a – US Census Bureau, 2000 Small Area Health Insurance Estimates b – US Census Bureau			

Table 2: City and County Health Insurance Estimates

- The percentage of uninsured persons in the City of Houston (30.9%) was higher than in Harris County (27.9%) in 2010.

- The percentage of uninsured persons in Harris County has increased over time. In 2000 the percentage was 19.7% and in 2010, the percentage was 27.9%.

Theme - Livability
Sub Theme - Cost of Living

Indicator - Affordability

Housing is a basic need with food and air. Ensuring that housing is affordable may correlate strongly with home ownership but neither of these are in absolute terms a basic necessity. The basic necessity is met with the supply of homes not with the cost. That said, it is a good policy for local governments to supply affordable homes. This helps to enhance the quality of life of citizens and to bolster their economic well-being, which ensures a more sustainable financial future (Blackburn, 2011). Housing **affordability** can be defined as relative, subjective, a product of family budget, a ratio, or residual. This would explain the gamut of definitions of housing affordability, but spending less than 30% of income on housing (Ratio standard) has taken the fore as the definition of affordability in the U.S. (Stone, 2006).

The relationship between the Cost of Gasoline and Housing Costs is also used to measure Affordability in this study. These two price indicators are selected based on the theory that travel costs (including time) and affordability of housing are two of the primary factors which influence where people live in urban areas. In urban economics households will maximize their bid-rent capability by locating close to the jobs commensurate to their ability to afford housing in the area (Stegman, 1969). Housing will probably always be more affordable the farther one travels from the central City, but gasoline prices influence the affordability to travel increasingly longer distances from the city. When comparing cities in the country with more than 250,000 people, Houston ranks 26th for affordability, with 46% of income going to housing and transportation costs. Philadelphia was first with 33%; New York was 4th with 37%; Chicago was 14th with 42%; and Los Angeles was 51st with 52% of income going to housing and transportation cost (Center for Neighborhood Technology, 2010).

Sustainability Benefit: The cost of gasoline in Houston was 20 cents lower than the average in the country in 2010. Houston is not affected by housing value decreases at the same rate as the rest of the country.

Sustainability Issue: The cost of gasoline is increasing. More people are spending more than 30% of their income on housing.

The following metrics are used to measure the indicator *Affordability*:
Figure 15: Gasoline Prices
Figure 16: Housing Affordability
Figure 17: Housing Affordability by Cost Quintiles
Figure 18: Median Home Price vs Gasoline Price
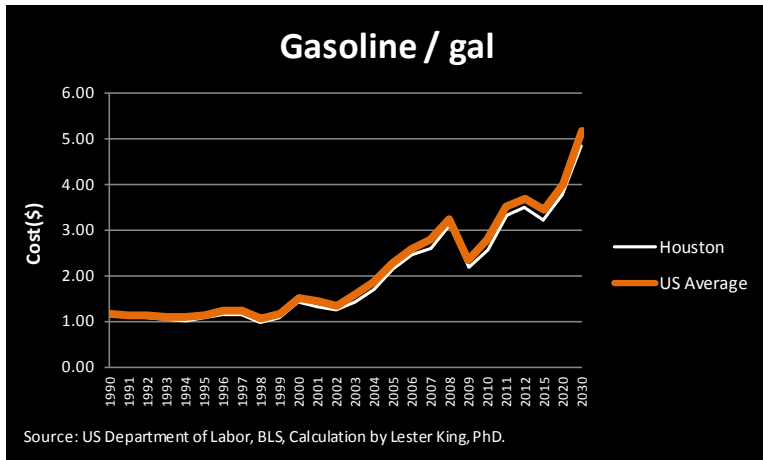
Figure 15: Gasoline Prices

- Gasoline prices in the Houston region compared to the average price across the country exhibit similar trends. Since there is very little difference between the trends then it suggests that the variation of increases and decreases exhibited in the figure above were the result of national and international policy as opposed to local dynamics.
- Figure 12 shows that although the Houston region and the national average price exhibit similar trends, over time the gap is widening. In 1990 the Houston average was five cents less; in Yr2000 Houston was almost 10 cents less and in Yr2010 the cost in Houston was approximately 20 cents less than the national average.
- The difference in the retail sale price of gasoline in the country compared to that in Houston doubled every 10 years between 1990 and 2010.
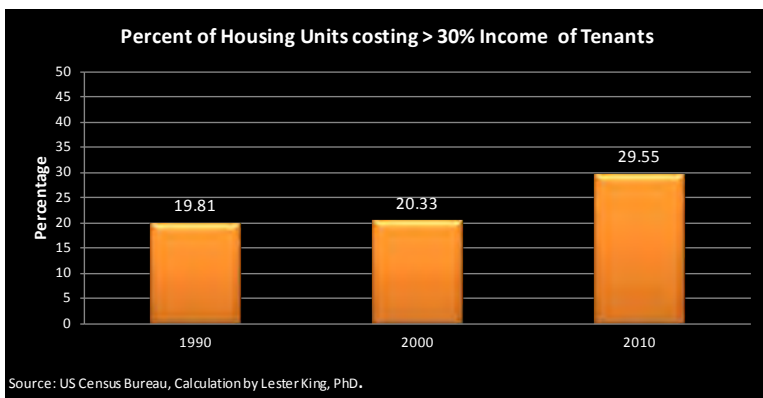
Figure 16: Housing Affordability

- The percentage of housing units in Houston where tenants spent more than 30% of their incomes on housing costs increased almost 50% in 2010 from 1990 and 2000 levels, which were relatively similar in percentage.

- In 2010, 30% or 104,140 housing units cost tenants more than 30 percent of their incomes.

- In 2010 the median monthly owner cost for households with a mortgage was $1,423 in the City of Houston (U.S. Census Bureau, 2011). Applying the 1/3 rule for affordability, this means that the average household needs to earn $51,228 to cover the cost of the mortgage at less than 1/3 of total annual income. In Houston 57% of the households earn less than $51,228 annually.

Source: US Census Bureau, Calculation by Lester King, PhD.
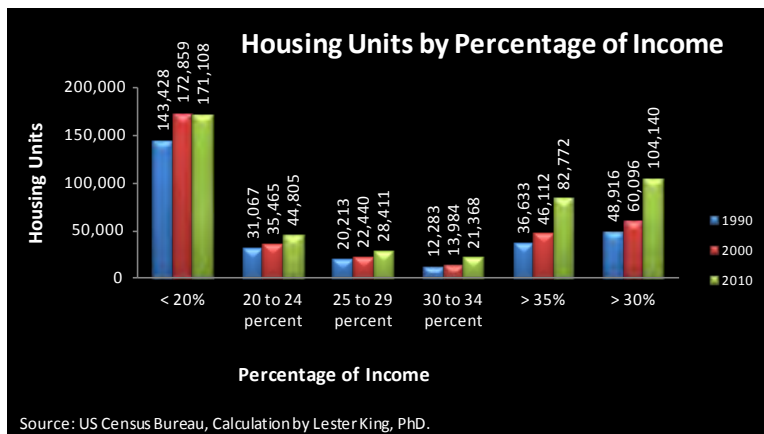
Figure 17: Housing Affordability by Cost Quintiles

- The above figure shows the dramatic increase in occupied housing units by those who would have to pay more than 35% of their income on housing costs. Between 2000 and 2010, approximately 40,000 more homes cost tenants more than 30% of their incomes. In comparison, between those same years approximately 56,000 more homes were added in Houston.

- The number of homes costing tenants less than 20% of their incomes decreased by 1,751 between 2000 and 2010.
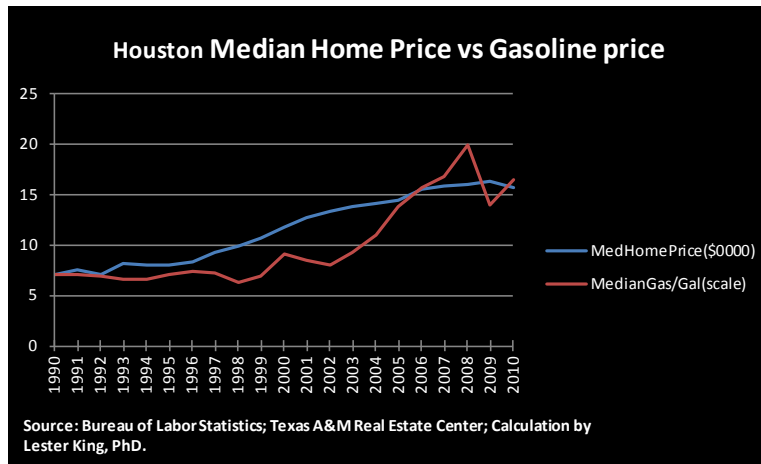
Figure 18: Median Home Price vs Gasoline Price

- The figure above shows the average gasoline price in the Houston region scaled for visual comparison purposes to meet the range of the median housing price.

- The figure shows there is no significant relationship between the trend in gasoline price and the trend in housing price in the Houston region, except that they are both increasing over time.

Theme - Livability

Sub Theme - Quality of Life

Indicator - Accessibility of Public Spaces

Quality of Life is difficult to measure since we have a diverse number of cultures and persons with individual differences within those cultures. However access to nature and open space has been proven effective in combating health and behavioral problems (Mitchell & Popham, 2008). **Accessibility of public spaces** enhances quality of life by offering a physical space for the interaction of people to form community and neighborhood networks (Alexander, Ishikawa, & Silverstein, 1977). Places where we want to encourage a high level of accessibility, and hence frequency of use such as commercial centers, transit lines, and community facilities such as parks should be no more than ¼ mile walking distance from population residences (Ewing, 1999). Houston ranked 32nd among the 63 largest cities in the country for pedestrian activity and incentives to walking (Walkscore, 2012). According to the Trust for Public Land (TPL), Houston ranked 21st among the 63 largest cities in the country, in terms of percentage of area devoted to parks with 13% (The Trust for Public Land, 2011).

Sustainability Benefit: Small public parks are relatively well dispersed across the city.

Sustainability Issue: Half the population does not have a public park within walking distance and few new parks are being developed.

The following metrics are used to measure the indicator *Accessibility of Public Spaces*:
Figure 19: City of Houston Access to Parks 2000
Figure 20: City of Houston Access to Parks 2000 – 2010

City of Houston Access to Parks 2000

Map Created by: Lester King, PhD
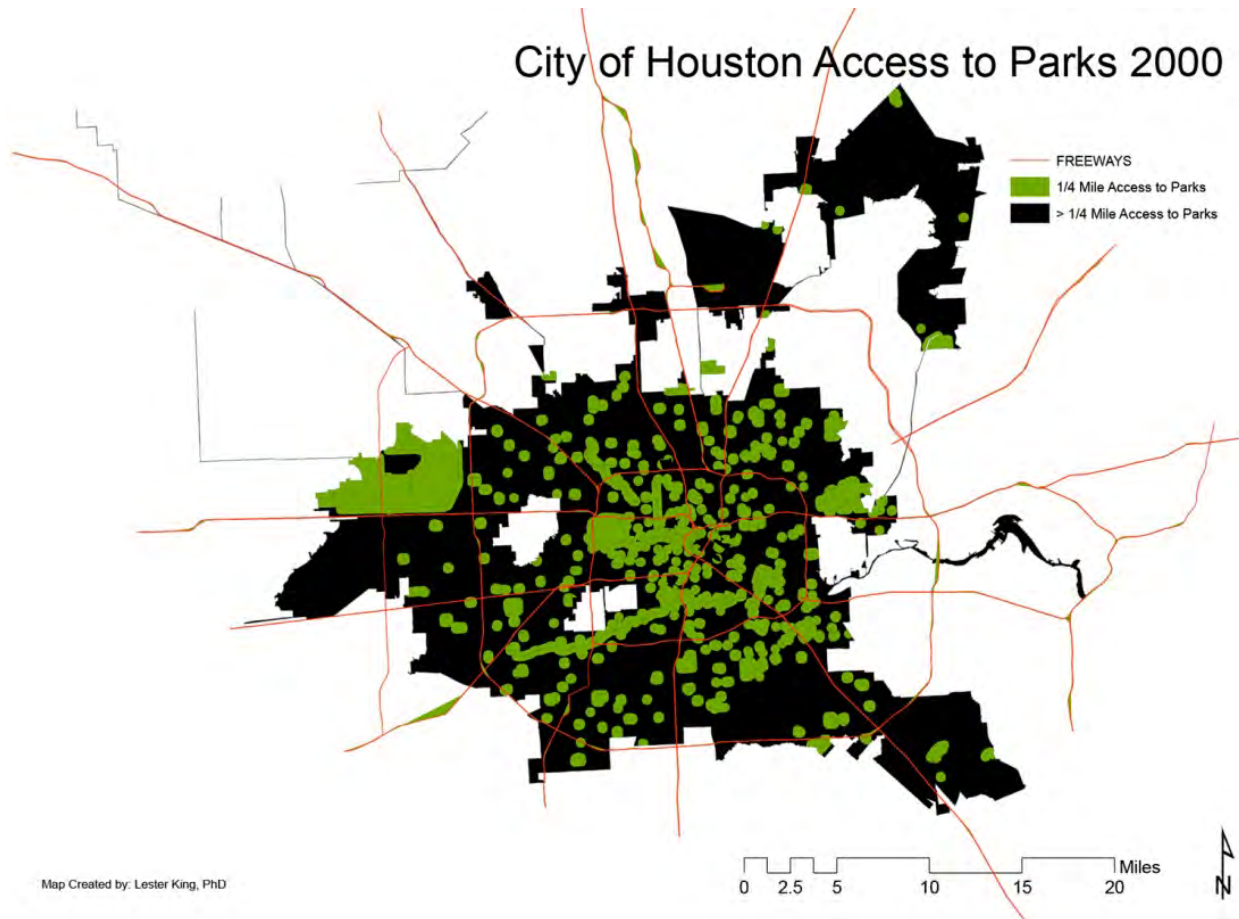
Source: Highways, City outline, Parks from the City of Houston GIS Department

Figure 19: City of Houston Access to Parks 2000

- In 2000 there were approximately 460,000 Houstonians living within a quarter mile walking of city parks.
- That number represents almost 25% of all Houstonians in 2000.
- Figure 15 shows that there are large areas without city parks on the west side of the city, the south and south east and north east sections.

City of Houston Access to Parks 2000 - 2010

Legend
— FREEWAYS
1/4 Mile Access to Parks 2000
1/4 Mile Access to Parks 2010
>1/4 Mile Access to Parks

0   5   10   20 Miles

Map created by Lester King, PhD. Source: City of Houston Parks and Recreation Department
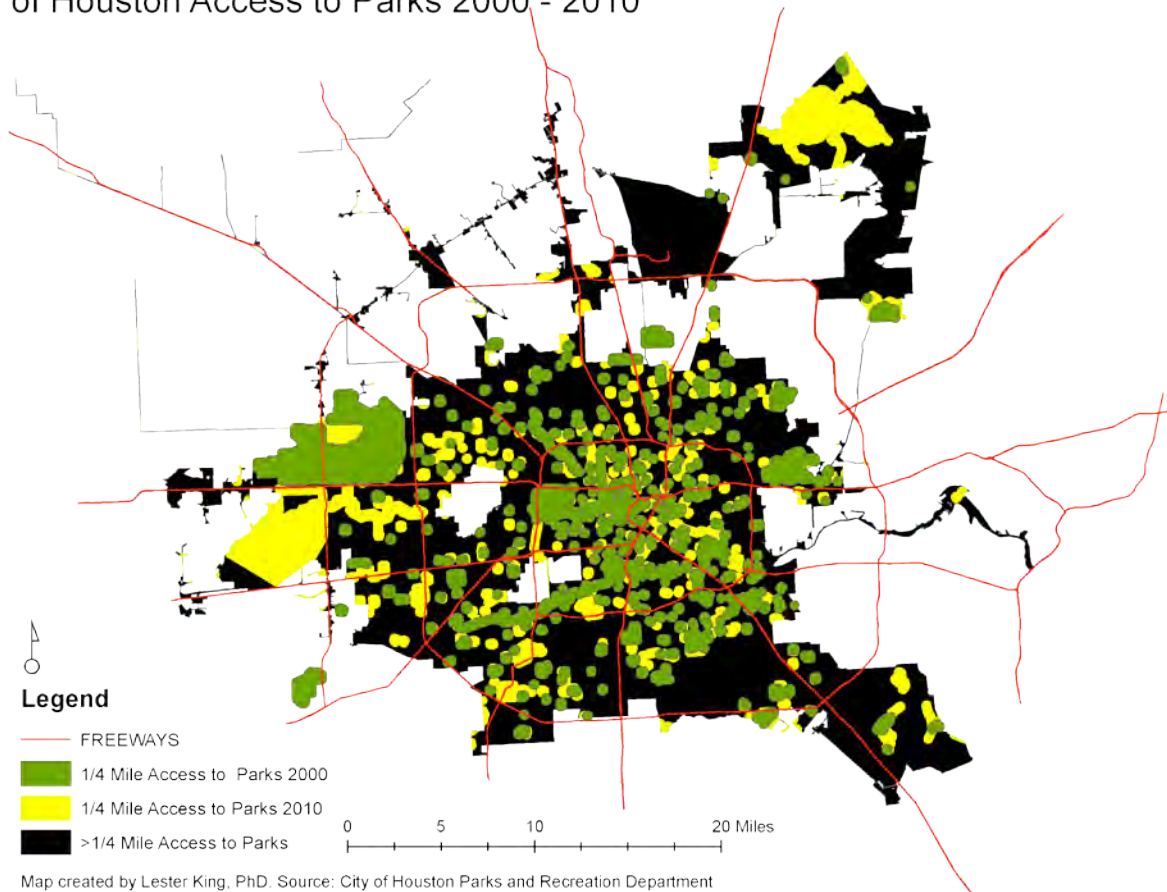
Figure 20: City of Houston Access to Parks 2000 – 2010

- A look at a map of existing parks in 2000 superimposed on a map of existing parks in 2010, shows the new areas classified as parks in 2010. These areas include pedestrian and bike trails, school parks shared by neighboring communities, and county parks.
- For 2010, there were almost 918,882 persons living within a quarter mile of parks in Houston.
- That figure represents 44% of the population living within walking distance of a park.
- Additionally a demographic analysis of access to parks in 2010 shows the following figures by race and ethnicity. White cohort 48%; Black cohort 41%; Hispanic cohort 44% living within ¼ mile to a park or open space.

Theme - Livability
Sub Theme - Health & Nutrition

Indicator - Food Deserts

Food deserts are correlated with low income neighborhoods, health and nutrition deficiencies, and fast food restaurants. According to the Centers for Disease Control and Prevention (CDC), food deserts are defined as 'areas that lack access to affordable fruits, vegetables, whole grains, lowfat milk, and other foods that make up the full range of a healthy diet' (Centers for Disease Control and Prevention, 2012). The CDC also states that there is no standard definition of food desert, however the US Department of Agriculture (USDA) defines a food desert as a census tract more than 1 mile from a supermarket with at least $2 million in annual sales (urban definition), and that at least 20% of the people living there are poor (US Department of Agriculture, 2012). This report uses the definition of any area more than 1 mile from a grocery store selling fresh fruits and produce as being in a food desert. The reason is because some small stores also sell produce that meet the CDC's definition and also some areas that are not necessarily poor, but are not within a mile to supermarkets will not be covered by the USDA definition.

Texas has the lowest number of supermarkets per capita in comparison to other states in the country (Manon, Giang, & Treering, 2010). The economic model that finds it strategic to locate a fast food store in a food desert is clearly different from the model that is used to locate grocery stores. Low income persons have to shop more frequently for retail items since they do not have enough stored wealth or storage space to stock up on consumer goods. Recently we have seen the emergence of several Farmer's Markets across the city (Turner, 2012). The increase of Farmer's Markets suggests that there is a local demand, which traditional grocery stores are not meeting. There are also reportedly more than 125 community and school gardens across the city (Blackburn, 2011).

Sustainability Benefit: The Food Desert in Houston is getting smaller.

Sustainability Issue: More than 700,000 people in Houston do not live within a mile of a grocery store selling fresh fruits and vegetables.

The following metrics are used to measure the indicator *Food Deserts*:
Figure 21: Houston Food Desert 1990
Figure 22: Houston Food Desert 2000
Figure 23: Houston Food Desert 2010
Figure 24: Houston Grocery Stores 1990 – 2010
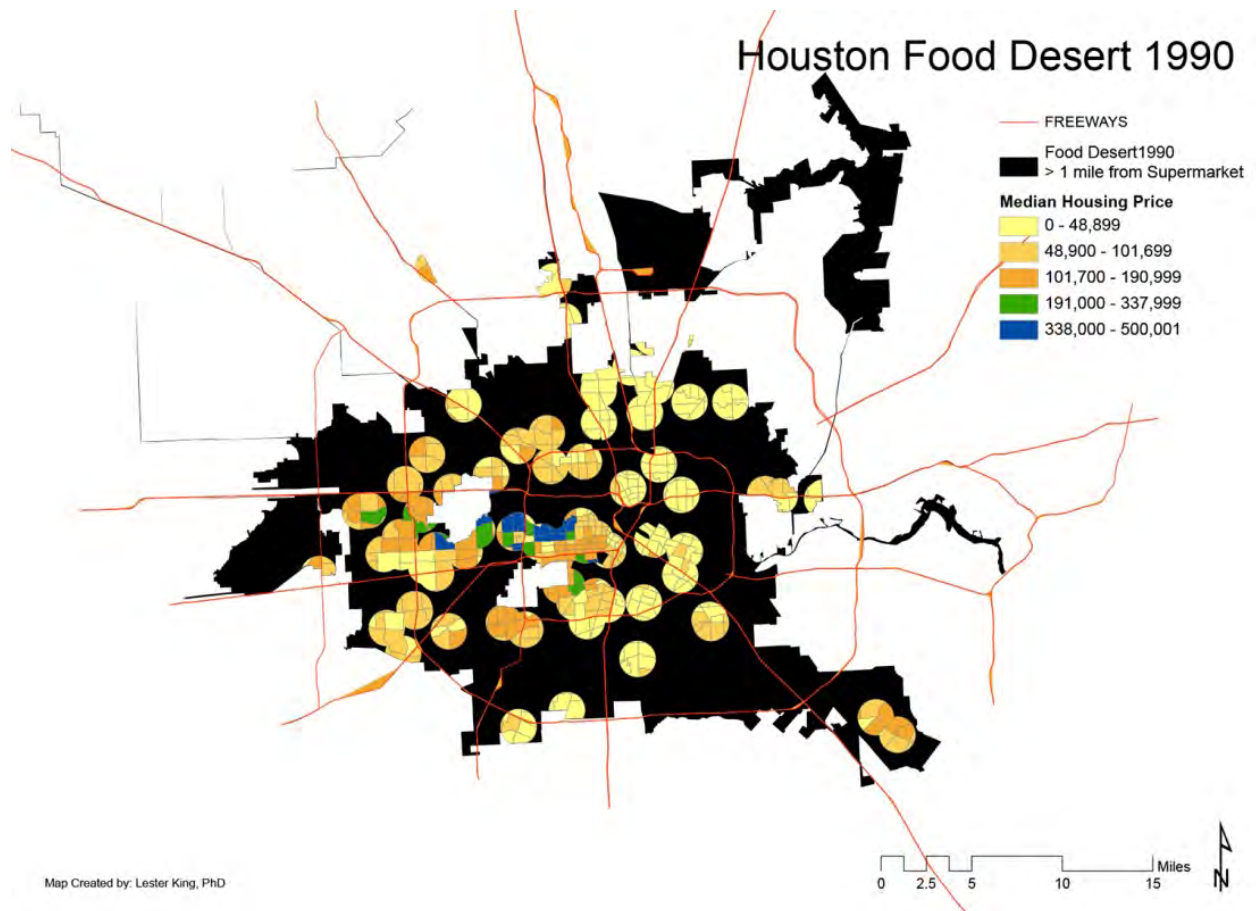
Source: Highways, City outline by City of Houston. Address locations of supermarkets by InfoUsa. Calculation of Food Desert by author.

Figure 21: Houston Food Desert 1990

- In 1990 63% or just over a million Houstonians lived more than 1 mile from a supermarket and hence lived in a Food Desert.
- The above figure shows that many of the supermarkets are located close to the major roads in Houston.
- In 2011 the top five grossing supermarket locations that were in existence in 1990 in Houston, were HEB, Randalls, Walmart, Fiesta Mart, and Whole Foods.
- Each of the above companies made over $60M in at least one location of their franchises in 2011.
- Both HEB and Randalls reported at least $120M for 2011 at one of their Westheimer locations.
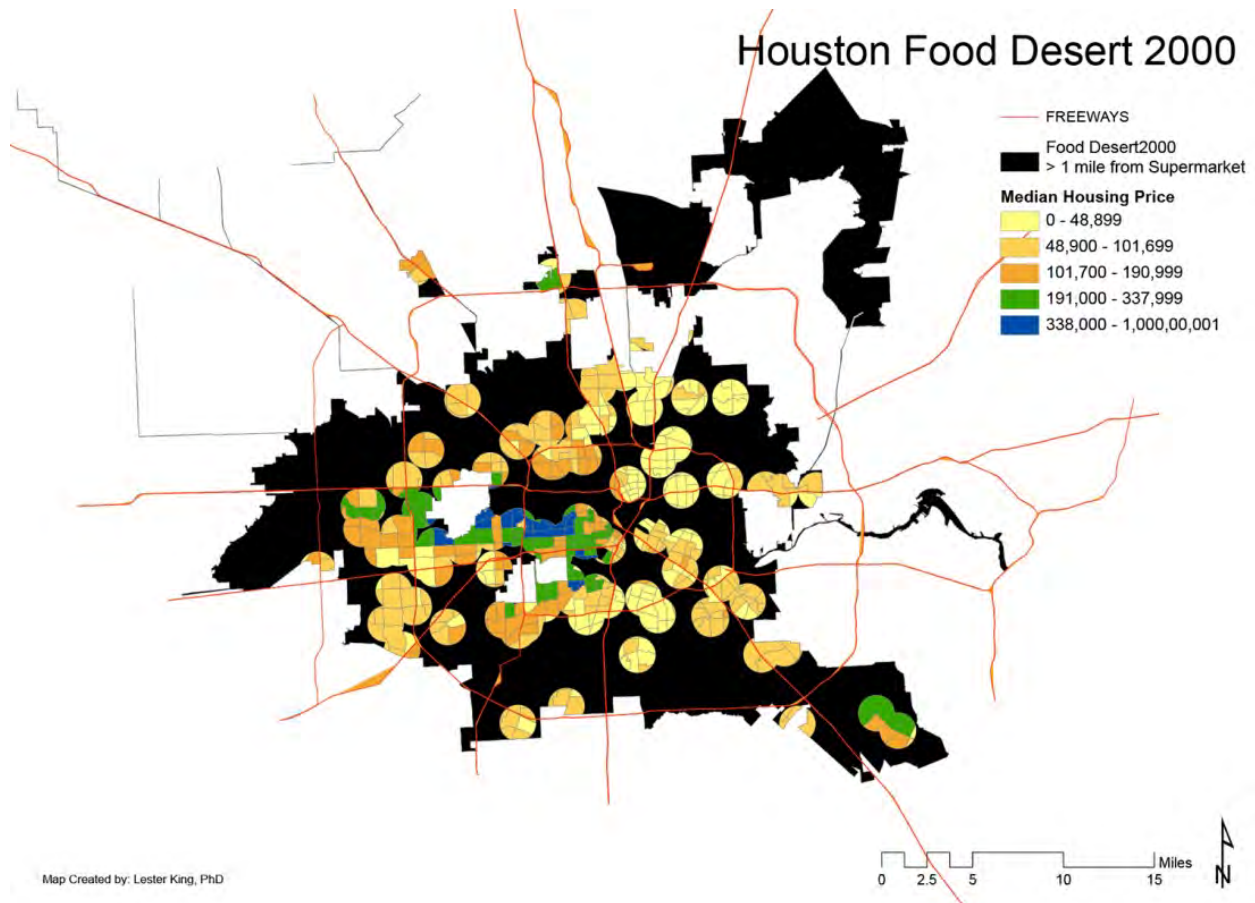
Houston Food Desert 2000

Source: Highways, City outline by City of Houston. Address locations of supermarkets by InfoUsa. Calculation of Food Desert by author.

Figure 22: Houston Food Desert 2000

- In 2000 56% of Houstonians or 1,089,022 people lived in the Food Desert.
- There were less than 150 supermarkets selling fruits and vegetables in the City of Houston in 2000.
- If supermarkets and people were spread evenly across the city, this would be the equivalent of one supermarket for every 4 square miles and catering to 13,000 persons each.
- Since supermarkets are not spread evenly across the city it suggests that many people drive more than a mile to the supermarket and also that some supermarkets cater to more than 13,000 persons each year.
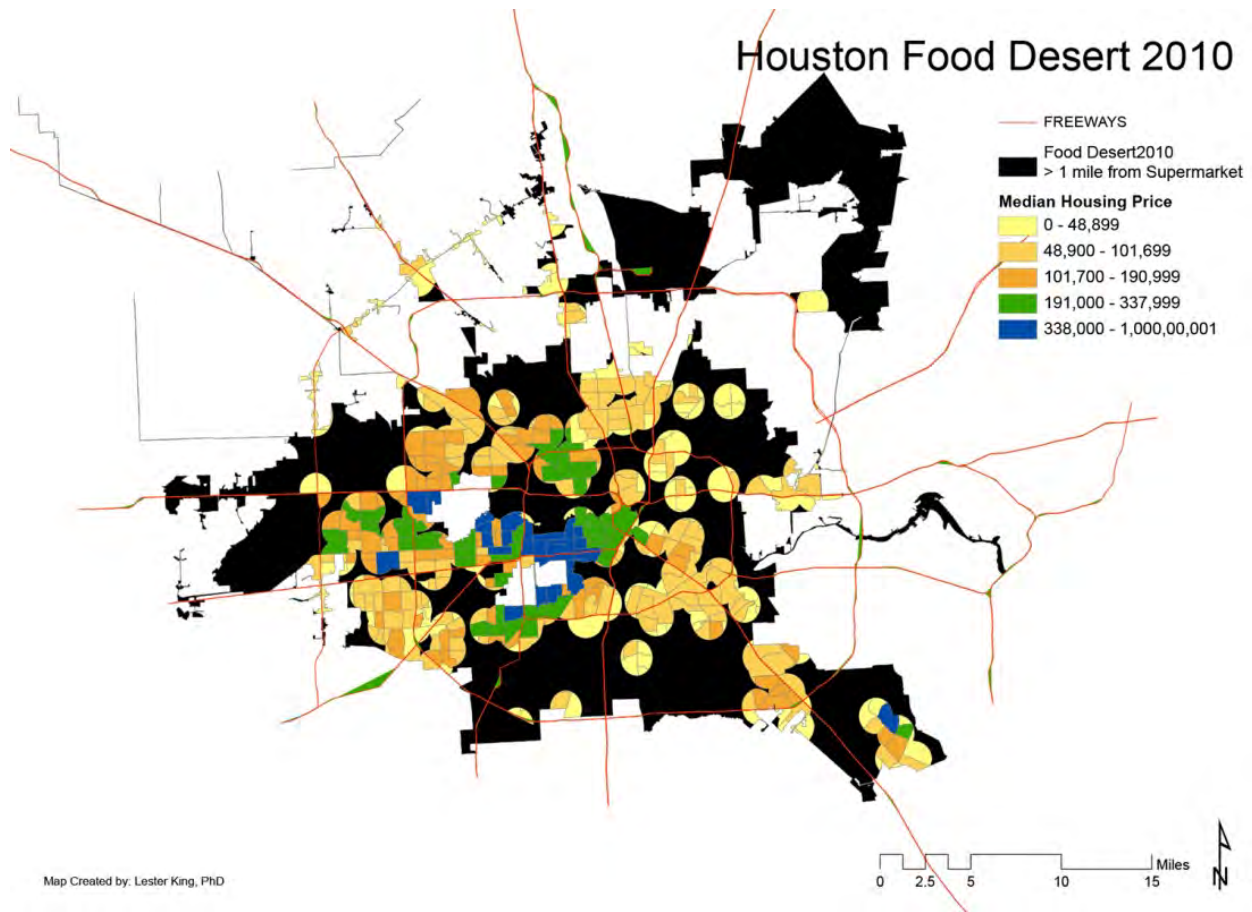
Source: Highways, City outline by City of Houston. Address locations of supermarkets by InfoUsa. Calculation of Food Desert by author.

Figure 23: Houston Food Desert 2010

- In 2010 there were about 750,000 persons living in a food desert accounting for 36% of the population. This is a big decrease in the number of food deserts compared to previous years.
- The above figure shows that the food desert is now primarily located in the south, far west, and northeast portions of the city.
- In the south central portion of the city, between Highway 288 and Interstate 45-South, the food desert continues to exist when comparing data from 1990 to 2010. This area is known as the Greater Third Ward neighborhood and is home to University of Houston and Texas Southern University.
- Some of the 1-mile regions around supermarkets show that the median housing value is under $50,000, therefore the food desserts in Houston cannot be explained by lower income levels alone.
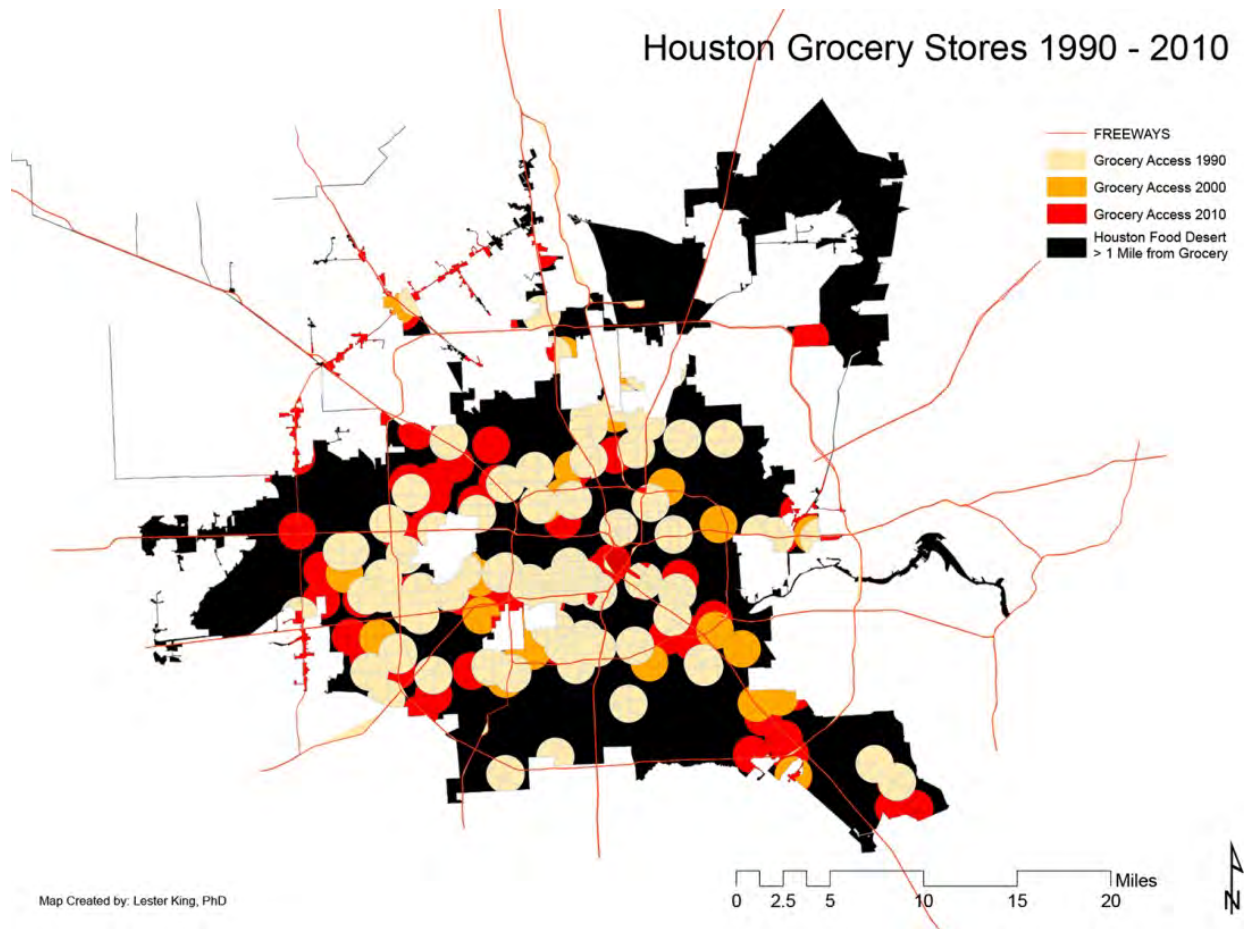
Houston Grocery Stores 1990 - 2010

FREEWAYS
Grocery Access 1990
Grocery Access 2000
Grocery Access 2010
Houston Food Desert > 1 Mile from Grocery

Map Created by: Lester King, PhD

Source: Highways, City outline by City of Houston. Address locations of supermarkets by InfoUsa. Calculation of Food Desert by author.

Figure 24: Houston Grocery Stores 1990 – 2010

- The above figure shows the expanded coverage of supermarkets across the city from 1990 to 2010, which lead to a decline of the food desert from affecting 63% of persons to affecting 36% of persons.
- Between 1990 and 2000 many new supermarkets were located around the inner city, within Loop 610, and south along Interstate 45.
- Between 2000 and 2010 many supermarkets were primarily located to the west and northwest of the city, with continued expansion along Interstate 45 to the south.

Social Development Policy Recommendations

THEME – Social Demography

Sub Theme – Population Growth: Indicator – Population Growth

- We need to encourage more **population growth within the City** through incentives to develop in the city as opposed to the suburbs.
- Population forecasts for the City of Houston should be based on the City of Houston boundaries and not the region.

Sub Theme – Education: Indicator – Education Attainment

- Major actions and interventions are needed to **reduce the education gap** among students of color and whites.
- Structure K-12 to **develop vocational tech training** that provides blue collar jobs.

Sub Theme – Community Involvement: Indicator – Voter Participation

- We need to strive to **increase voting** since it is a major cornerstone to any democracy.
- Elected officials need to find ways to **demonstrate accountability to citizens**, **adoption of a comprehensive sustainability indicators program** will aid this goal.

THEME – Poverty

Sub Theme – Inequality: Indicator – Income Inequality

- **Improved skills and training** needs to be developed to reduce income inequality.
- A **local or state taxing structure to reduce income inequality** would allow for systematic approach to this issue.

Sub Theme – Poverty Level: Indicator – Poverty Rate

- Need to **establish a commission on the root causes of poverty** which often link back to underperforming schools, and inadequate job skills.

Sub Theme – Healthcare Delivery: Indicator – Health Coverage

- Need to **attract more jobs that offer healthcare and livable wages**.

THEME – Livability

Sub Theme – Cost of Living: Indicator – Affordability

- Citizens in Houston pay more for transportation as a percentage of income than other cities of comparable size. **Improving transit options** would help to alleviate this burden.

Sub Theme – Quality of Life: Indicator – Accessibility of Public Spaces

- Houston needs to **aggressively develop more parks and green space**.

Sub Theme – Health & Nutrition: Indicator – Food Deserts

- City of Houston needs to actively **attract more grocery stores selling fresh fruits and vegetables** across the city.

Houston Sustainable Development Indicators:
A Comprehensive Development Review for Citizens, Analysts and Decision Makers

HOUSTON
SUSTAINABLE DEVELOPMENT *INDICATORS:*
A Comprehensive Development Review for Citizens, Analysts and Decision Makers

ECONOMIC DEVELOPMENT
PILLAR OF SUSTAINABILITY

LESTER KING

Houston Sustainable Development Indicators:

A Comprehensive Development Review for Citizens, Analysts and Decision Makers

by

Lester King, PhD, AICP, LEED

Economic Development Pillar of Sustainability

Theme - Economic Development
Sub Theme - Employment

Indicator - Employment Status

In 2010 survey of area residents, 38% of respondents stated that the biggest problem facing Houston was unemployment, poverty and the cost of loving (Klineberg, 2010). Employment is essential to gain access to health care, quality shelter, good communities, and quality of life among many other things. Education is a fundamental step in the process and indicators like the Drop-out Rate among high school students show trends leading to vulnerabilities like employment stability (Sanborn, 2012). In comparison to the 63 largest cities in the country Houston had the 18th highest unemployment rate in 2010.

Sustainability Benefit: The unemployment rate for Hispanics, which are the fastest growing segment of the population has not increased significantly between 1990 and 2010.

Sustainability Issue: In 2010 Houston had a very high unemployment rate at 10 percent.

The following metric, Figure 25: Unemployment Rate, is used to measure the indicator *Employment Status.*
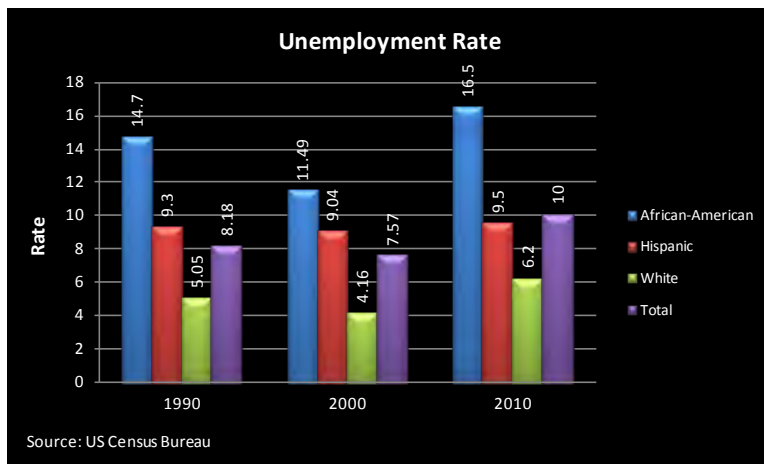
Figure 25: Unemployment Rate

- African Americans had a 16.5% unemployment rate in 2010. This is the highest rate of any racial or ethnic group and hence it demonstrates that African Americans are at a disadvantage when it comes to employment and job security in Houston.
- The unemployment rate among Hispanics remained stable at around 9.5%. This might lead some to erroneously state that Hispanic persons were not affected by the downturn in the economy starting in 2007.

- All groups show a reduction in unemployment percentage in 2000 and then an increase in unemployment in 2010. African Americans are the most adversely affected group in terms of unemployment.

Theme - Economic Development
Sub Theme - Macroeconomic Performance

Indicator - Primary Jobs and Green Jobs

Traditionally **primary jobs** (manufacturing) were considered the anchors of local economies and essential for reporting economic success. However sustainability promotes a more local emphasis on natural resources and economy to deter exploitation of weak economies by more robust ones. Local economies cannot sustain themselves without external capital since money will always leave the local economy through simple things like external purchases and people travelling to other places. Therefore the dilemma becomes, how can we calculate exactly the sustainable amount of external capital needed to generate the right mix of primary jobs to sustain local economies? This indicator looks at the development of primary jobs as an indicator to monitor the flow of new capital in the local economy (Leigh & Hoelzel, 2012). The city of Houston ranked 23rd among the largest 63 cities in the country, in terms of percentage of manufacturing jobs (U.S. Census Bureau, 2011). For this indicator primary jobs are defined as manufacturing jobs plus health sector jobs, for reasons as subsequently explained.

The indicator also looks at **green jobs** because they ensure that both private gains and public stewardship goals are met. Companies with job descriptions that qualify as green jobs, should be more resource efficient and hence more sustainable (McDonough & Braungart, 2002). Green Jobs can either be monitored by identifying products and services that are created or by the operational procedures followed in a company. In either case the products or procedures should improve or reduce impacts on the environment (Bureau of Labor Statistics, 2010).

Sustainability Benefit: Although traditional primary jobs were considered exclusively manufacturing, globalization has enabled the capture of foreign exchange from other sectors aside. Health care jobs in Houston, which are primarily service jobs, constitute a significant percentage of all jobs because the Texas Medical Center is the largest medical center in the world and attracts patients and researchers from all over the world. This is why primary jobs in Houston are defined as manufacturing jobs plus medical jobs in this study. The fact that Houston is not solely dependent on manufacturing for new capital creates a stronger base for a more sustainable local economy. This is especially important due to the lack of national and international competitiveness in the global manufacturing economy.

Sustainability Issue: Even with gains in medical jobs, these jobs plus manufacturing jobs, constitute less than one quarter of all jobs. High demand for single occupancy vehicles and the dependence, in Houston, on air conditioning contributes negatively to the environment and offsets both public and private gains from green jobs.

The following metrics are used to measure the indicator *Primary Jobs and Green Jobs*:

Figure 26: Houston Jobs 1990-2040

Houston Jobs 1990 - 2040

Source: 1990, 2000, 2010 - CTPP, 2010 health HGAC, after 2010 calculation by Lester King, PhD

Figure 26: Houston Jobs 1990-2040

- In 1990, 22% of all jobs were primary jobs; in 2000, 18% of all jobs were primary jobs; in 2010 23% of all jobs were primary jobs. Primary jobs include traditional manufacturing jobs and medical jobs.
- Manufacturing jobs were 9% of all jobs in the city in 2010.
- The above figure shows that Houston has had tremendous growth in jobs between 1990 and 2000 adding almost 1 million jobs. In contrast the city added approximately 73,000 jobs between 2000 and 2010.
- Medical jobs in Houston are growing at a faster rate than manufacturing jobs. Manufacturing jobs have dropped by 7 percentage points between 1990 and 2010 relative to all jobs. Medical jobs have grown by almost 6 percentage points for that same period relative to all jobs.
- The number of medical jobs has now surpassed the number of manufacturing jobs in the city.

Green Jobs in Texas 2010

Category	Value
Total all	229,685
Total all Private	169,367
Professional, Scientific, Technical	35,835
Construction	34,308
Manufacturing	27,445
Administrative and Waste	22,019
Trade	17,002
Utilities	10,963
Transportation and Warehousing	6,855
Other except, Public Admin	5,734
Natural Resources and Mining	3,170
Leisure and Hospitality	915

Source: U.S. Dept of Labor, BLS

Figure 27: Green Jobs in Texas

- In 2010 Texas had a total of 229,685 Green Jobs. This was approximately 2% of the total number of jobs in Texas.
- The industries with the highest number of green jobs in Texas were Professional, Scientific, Technical – 35,835; Construction – 34,308; and Manufacturing – 27,445.
- The industries with the highest percentage of green jobs in Texas were Utilities – 16%; Professional, Scientific, Technical – 6.3%, followed by Construction – 6.1%.
- If all of the green jobs in Texas were in the Houston Metropolitan Statistical Area (MSA) region, they would only constitute 7% of all jobs in the Houston MSA region.
- Applying that 7% estimate as a fraction of the total personal income in the Houston MSA region ($217 trillion). We can estimate a target for the green jobs market to contribute $15.1 billion to personal income in the Houston MSA region.
- Applying the 2% state level estimate of green jobs to the total number of jobs in the City of Houston in 2010 would yield an estimated 32,000 green jobs in the City of Houston.

Theme - Economic Development
Sub Theme - Earnings

Indicator – Income

Growth in income is an important summary indicator that shows the rate at which private gains increase over time. This is especially important in an environment where municipalities compete for population and economic growth, as well as more basic things such as keeping up with the rate of inflation. The City of Houston ranked 45th out of the largest 63 cities in the country in terms of median household income in 2010. The median household income in Houston was $42,962 in 2010. New York City ranked 16th highest in terms of median household income and California had 9 cities in the top 20 highest household income ranking, with San Jose City as the highest in the country with a median household income of $79, 405 (U.S. Census Bureau, 2011).

Sustainability Benefit: The Houston region grew to surpass the Boston, Philadelphia, and San Francisco regions by 2006 and has maintained those gains. The Houston region is now the sixth largest metro region in the country in terms of Personal Income.

Sustainability Issue: The 2008 economic crises affected Houston MSA more that the Dallas MSA. This shows that the Dallas economy, which is the largest in the state of Texas, retained more jobs.

The following metrics are used to measure the indicator *Income*:
Figure 28: US Personal Income by MSA
Figure 29: Personal Income Houston vs Comparative Metros
Figure 30: Per Capita Income Houston MSA

Source: US Dept. of Commerce, BEA
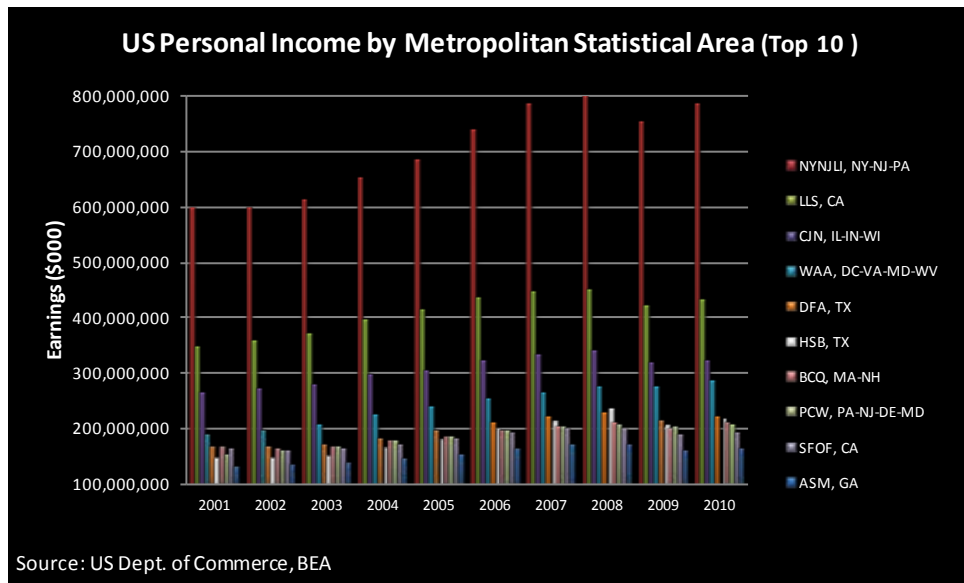
Figure 28: US Personal Income by MSA

- The top ten metropolitan areas in order of personal income by place of work in 2010 were as follows: New York-Northern New Jersey-Long Island (NYNNJLI), NY-NJ-PA – $785,121,844,000; Los Angeles-Long Beach-Santa Ana (LALBSA), CA - $430,869,194,000; Chicago-Joliet-Naperville (CJN), IL-IN-WI - $321,124,866,000; Washington-Arlington-Alexandria (WAA), DC-VA-MD-WV - $286,158,609,000; Dallas-Fort Worth-Arlington (DFA), TX - $221,321,666,000; Houston-Sugar Land-Baytown (HSB), TX - $217,004,867,000; Boston-Cambridge-Quincy (BCQ), MA-NH - $208,433,714,000; Philadelphia-Camden-Wilmington (PCW), PA-NJ-DE-MD - $205,731,927,000; San Francisco-Oakland-Fremont (SFOF), CA - $191,330,208,000; Atlanta-Sandy Springs-Marietta (ASM), GA - $163,796,051,000.
- The total metropolitan portion of US Personal Income was $8 Trillion in 2010. The top ten ranked metro areas accounted for 38% of the total personal income in the U.S.
- The top ranked 4 metro areas, according to Figure 28, were the New York, LA, Chicago, and Washington DC regions. These regions accounted for 23% of the total US Metro area earnings. The remaining 6 metros in the top ten ranking contributed 15% of the US total and are similar in income numbers.

US Personal Income by Metropolitan Statistical Area (Selected Metros)

Source: US Dept. of Commerce, BEA
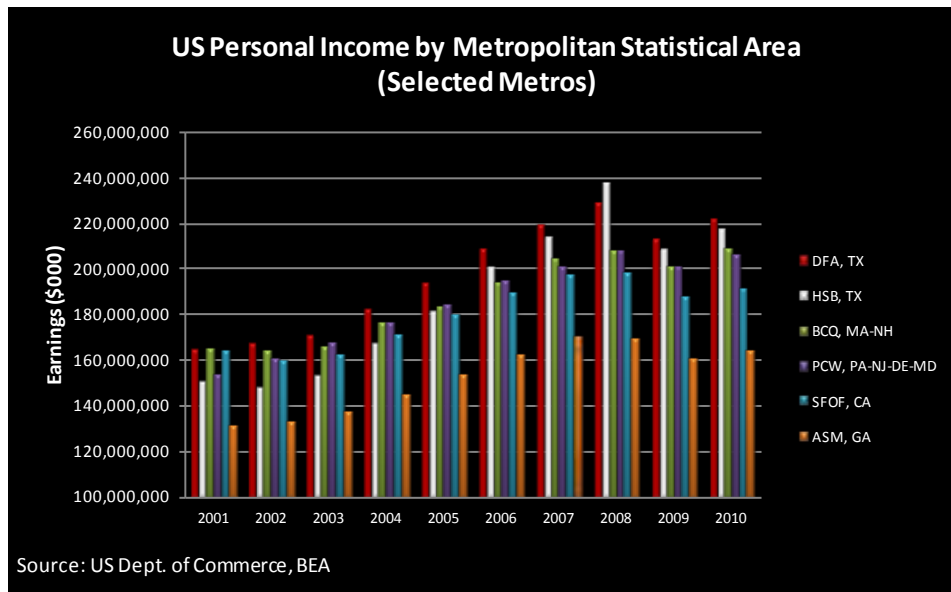
Figure 29: Personal Income Houston vs Comparative Metros

- Of the six similar metro regions in the top ten in the country according to Personal Income, the Dallas region reported the highest income in 2010.

- The Houston region made strong gains, in this comparative cohort, to become the top ranked region in 2008, and the highest grossing region across the 10 years of data collection between 2001 and 2010. However, the gains were not maintained after 2008 when all metro areas reported lower income earnings and Dallas again became the highest ranked metro according to the selected cohort.
- The Houston region surpassed the Boston, Philadelphia, and San Francisco regions by 2006 and maintained those gains. The Houston region is now the sixth largest grossing metro region in the country in terms of Personal Income.
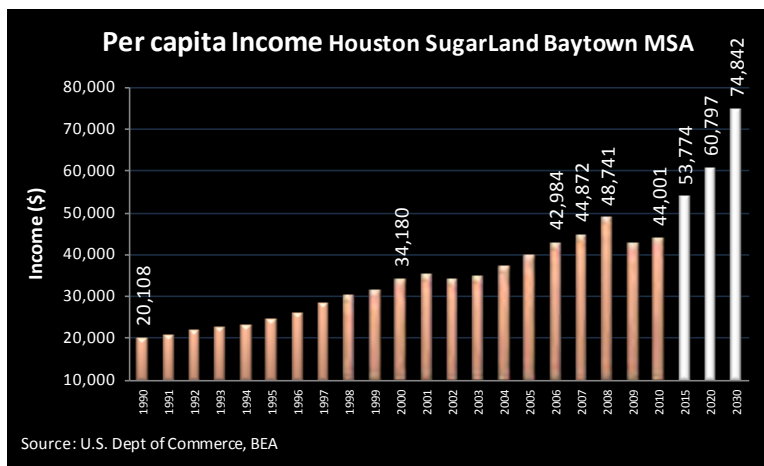
Figure 30: Per Capita Income Houston MSA

- The per capita income in the Houston – SugarLand – Baytown MSA reached a high of $48,741 before the economy slowed.
- Since per capita income in 2010 ($44,001), was a little below 2007 levels ($44,872), we can estimate that the recession in the economy in 2007 set us back approximately 3 years.
- By 2015 if the historical trend continues as exhibited between 1990 and 2010, the Houston MSA should reach a per-capita income of $53,774.

Theme - Consumption and Production

Sub Theme - Waste Generation and Management

Indicator - Waste Generation

In the United States, there were 250 million tons of municipal solid waste generated in 2010. Paper and paperboard constituted 28.5% of this total and another 28% was organic wastes such as food scraps, and yard trimmings (US Environmental Protection Agency, 2010). The data presented here covers waste generation. However, the other sustainability component of waste is the environmental justice issue of where landfills are located. Blackburn (2011) reports that 57% of persons living within a half mile of hazardous sites in Harris County are below the poverty line.

Sustainability Benefit: Municipal Solid Waste disposal numbers are decreasing in the 13 county region.

Sustainability Issue: Available data are estimates because private waste haulers account for a large portion of the market and do not have to report tonnage by types of waste or sources to the state. It is not clear the impact this may have on the reduction in tonnage reported.

The following metrics are used to measure the indicator *Waste Generation:*
Figure 31: Houston Region MSW Disposal (tons)
Figure 32: Houston Region MSW Disposal Rate (lbs/person/day)
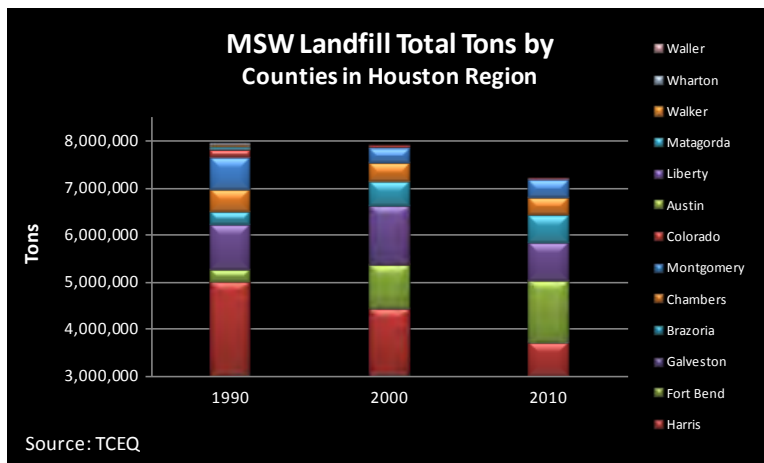
Figure 31: Houston Region MSW Disposal (tons)

- Waste statistics are reported for the Houston-Galveston 13 county region. Waste generated in one county can be deposited in other counties.
- The total tonnage of municipal solid waste dropped tremendously in 2010 when compared to levels in 1990 and 2000.

- The total tonnage of municipal solid waste reported for the region was 7,946,258 tons in 1990; 7,907,760 tons in 2000; and 7,214,143 tons in 2010.
- Most of the waste was landfilled in Harris County, Fort Bend County, and Galveston County.
- Between 1990 and 2010 Harris County had a reduction in the amount of solid waste landfilled; while Fort Bend County had an increase in the amount of waste landfilled.
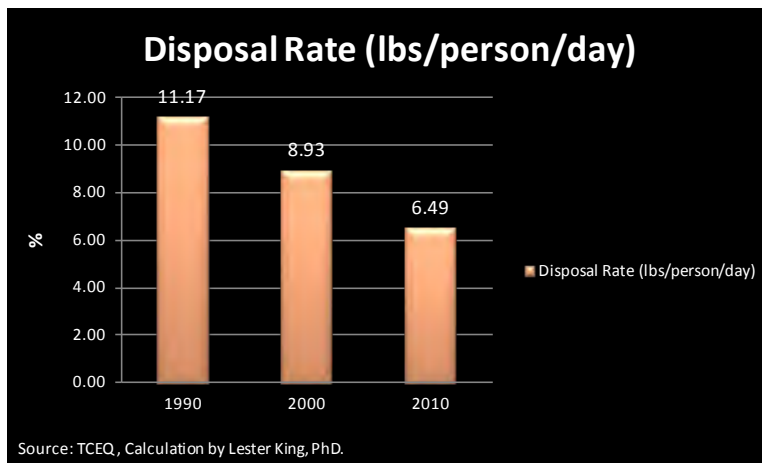
Figure 32: Houston Region MSW Disposal Rate (lbs/person/day)

- The Disposal rate measured in pound per person per day serves as a standardized measure for compared waste statistics.
- Between 1990 and 2000 the disposal rate dropped in the Houston-Galveston 13 county region from 11.17 lbs/person/day to 6.49 lbs/person/day.

Theme - Consumption and Production

Sub Theme - Energy Use

Indicator - Energy Consumption

Coal, natural gas and oil are the carbon-based resources we depend on for energy. These resources are all non-renewable and as such raise the issue of sustainability. Additionally, these resources emit high levels of pollution into the atmosphere, which affect our health and the health of other living organisms. There are three elements in our ecosystem that we have the capability to harness to produce energy to power our way of life. Those elements are carbon, plutonium and hydrogen. Since the use of plutonium is a threat to peace and hydrogen needs further research, we will be dependent on carbon-based fuels for some time (Tour, Kittrell, & Colvin, 2010).

Sustainability Benefit: We have a robust supply of infrastructure to ensure redundancy of energy access for most areas in the city.

Sustainability Issue: Houstonians are dependent on air conditioning for the majority of the year.

The following metrics are used to measure the indicator Energy Consumption:

Figure 33: Centerpoint Energy Residential Energy Use History
Figure 34: Houston vs National Ave Residential Energy Use
Figure 35: Houston Residential Energy Demand vs City Administration and HISD
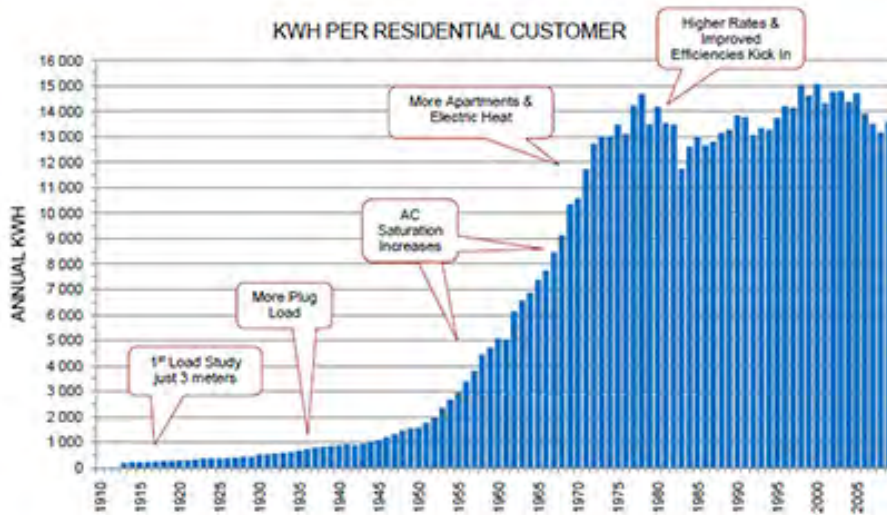
Figure 33: Centerpoint Energy Residential Energy Use History

- The figure shows the steep rise in electricity demand between the 1950s and 1970s, which was largely a result of air conditioning.
- Since the 1970s customers in the Houston region consumed an average of more than 13,000 kwh/ year, worth of electricity, except for a few years in the 1980s.

Houston vs National Average Residential Energy Use

Source: Centerpoint Energy 2011 Annual Report; US EIA, Electric Power Annual 2011
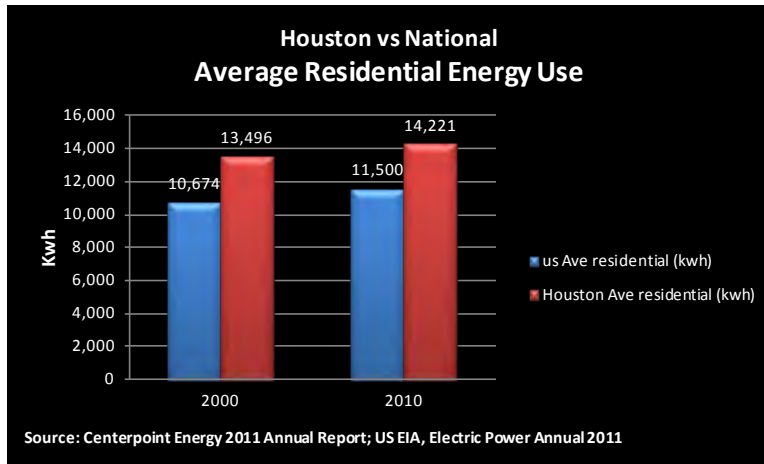
Figure 34: Houston vs National Ave Residential Energy Use

- The average household in the CenterPoint region, which includes Houston, consumes more electricity per year than the national average.
- Between 2000 and 2010 both the national average and the average Houston household increased electricity use by approximately 2,700 Kwh.

Houston Residential Energy Demand vs City Administration and HISD

Source: Centerpoint Energy 2011 Annual Report; HISD Energy Report 2011; EPA 2010
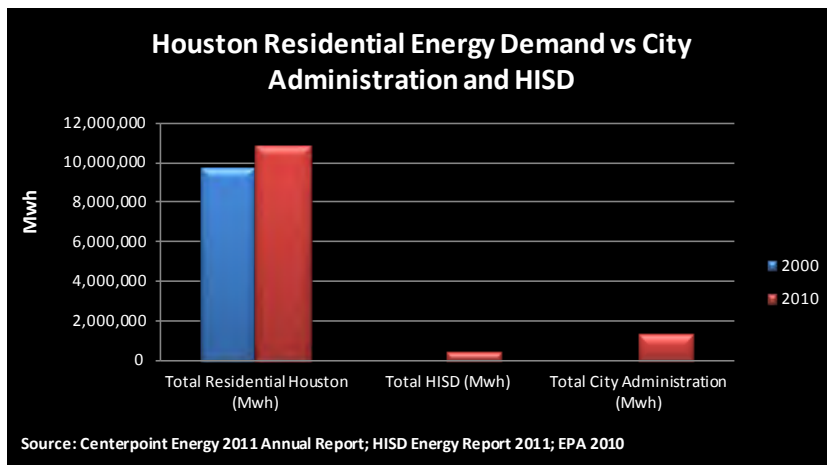
Figure 35: Houston Residential Energy Demand vs City Administration and HISD

- The total residential electricity demand in Houston was almost 11 million Mwh in 2010.
- A previous study by Edward Glaeser et.al. (2010) showed that the Houston metropolitan area generated 18.74 MWh of electricity in 2000 (Glaeser & Kahn, 2010). Using our estimate of 13,496 kwh per household and an estimated 1,462,665 households in the Houston MSA we get 19.74Mwh of electricity used by the Houston MSA.

- The total electricity consumption for City of Houston facilities was approximately 10% of the residential demand in 2010.
- HISD electricity consumption was approximately 4% of residential use in the City of Houston.

Theme - Transportation
Sub Theme - Access

Indicator - Access to Public Transportation

Dr. Martin Luther King, Jr. commented on the failure of public transit to overcome disparities in access to jobs among racial minorities. Several historical studies in the country have pointed to the need to connect central city residents with jobs using transit (Sanchez, 1999). **Access to Transit** in this study will be measured by Euclidean proximity to bus stops, however other accessibility measures such as frequency of bus routes; proximity to destinations; and congestion time also contribute to accessibility issues.

Sustainability Benefit: Houstonians have moderate access to transit stops that are within walking distance for most areas in the city.

Sustainability Issue: Houston has poor street connectivity and neighborhoods tend to be separated from places of work and school. As a result even though accessibility to bus stops is good, trip times are long.

The following metric, Percentage of population and housing units close to transit stops is used to measure the indicator *Access to Public Transportation.*
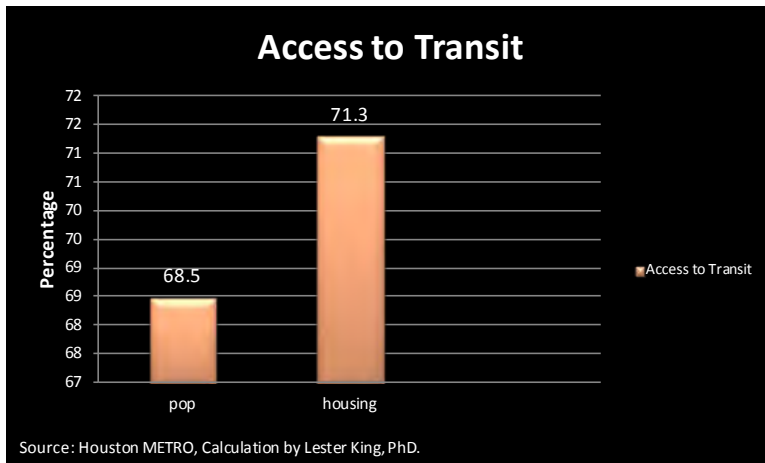
Figure 36: Percentage of population and housing units close to transit stops

- The percentage of population within a quarter mile from a bus stop was 68.5% in 2010.
- The percentage of housing units within a quarter mile of a bus stop was 71.3% in 2010.

Theme - Transportation
Sub Theme - Demand

Indicator - Vehicle Miles Traveled

Reducing the amount of **vehicle miles traveled** (VMT) is one method for curbing air pollution and traffic congestion. Population growth and economic development inhibit reductions in VMT (ICF International, 2011). Most contemporary urban planners agree that locating jobs and services close to homes would aid in reducing VMT numbers (Cervero & Duncan, 2006). In a representative sample of Harris County residents, 48% thought that traffic was the biggest problem in 2005, while in 1990 9% thought that traffic was the biggest problem (Klineberg, 2005). In 2007 the City of Houston reported the highest auto sales of any city in the country, with 379 auto dealers reporting $9.4 billion dollars of sales (U.S. Census Bureau, 2011).

Sustainability Benefit: High VMT is an indicator of a robust economy.

Sustainability Issue: VMT per capita in Houston is projected to increase over time.

The following metric, Figure 37: Annual VMT PerCapita, is used to measure the indicator *Vehicle Miles Travelled.*
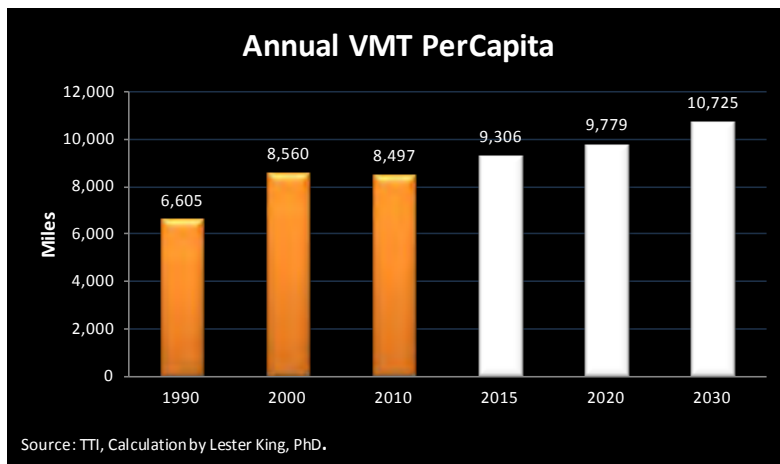
Figure 37: Annual VMT PerCapita

- The annual VMT per capita is projected to increase in Houston.
- Annual VMT per capita decreased slightly between 2000 and 2010. The 2000 VMT was 8,560 miles per person. The 2010 VMT was 8,497 miles per person.
- Annual VMT is expected to rise above 10,000 miles per person by 2030. This is greater than five times the distance between Houston and New York City (1,600 miles).

Theme - Transportation
Sub Theme - Mode

Indicator - Travel Choice

The private automobile has long been the preferred method of travel for most Houstonians (Klineberg, 2010). Is the percentage of persons traveling in private vehicle alone a sign of decreasing community standards; an indicator that population growth is occurring in areas not serviced by public transit; or an indicator that the current transit system, which relies heavily on buses is not efficient?

Sustainability Benefit: No benefit identified in Houston

Sustainability Issue: The percentage of persons travelling alone by private car is increasing in Houston.

The following metric, Figure 38: Alternative Means of Travel, is used to measure the indicator *Travel Choice*.
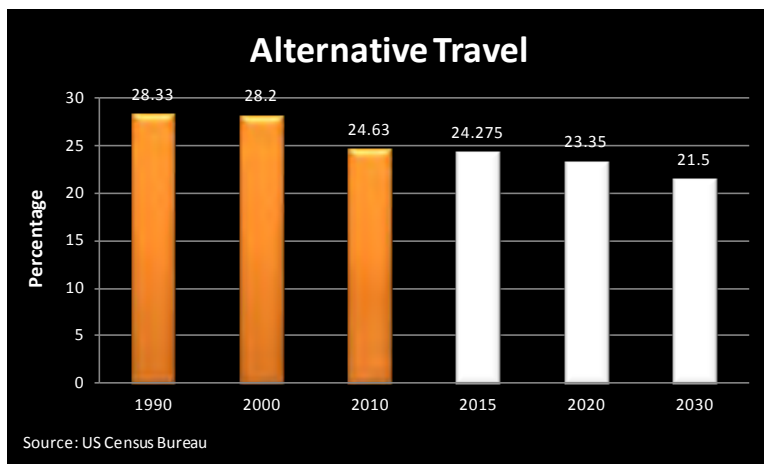
Figure 38: Alternative Means of Travel

- A higher percentage of people are traveling alone by private car in Houston.
- In 1990, 28% of persons did not travel alone by car. By 2010, that number was 25%.
- If the present trend continues, the number of persons not traveling alone will decrease to 21.5% by 2030.

Economic Development Policy Recommendations

THEME – Economic Development

Sub Theme – Employment: Indicator – Employment Status

- Need to match skills training from universities and colleges with demand from employers. **Collaboration** between universities, community colleges, school district, and major employers, with support from the city, is necessary. Develop apprenticeships programs.
- Utilize Science, Technology, Engineering, Math **(STEM)** training programs more effectively.

Sub Theme – Macroeconomic Performance: Indicator – Primary Jobs/Green Jobs

- **Develop alternative energy industry** to attract high end jobs in that sector.
- **Develop IT/ Advanced Technologies skills** and knowledge labor force.
- Need to improve quality of life to attract professionals and jobs (eg. Arts, eco-tourism, attractions).
- Need to foster and **grow Life Science and Bio-Technology industries** in Houston.

Sub Theme – Earnings: Indicator – Income

- Foster **development of energy trading** (Collaboration between Greater Houston Partnership, Banks, and Universities).
- Develop our opportunity to **increase international trade** based on large diversity.

THEME – Economic Development

Sub Theme – Waste Generation and Management: Indicator – Waste Generation

- Reporting **requirement for waste haulers to report sources of waste collected**.
- We need to be more conscious about **decreasing land fill space** to work towards a green and sustainable region.
- City of Houston needs to **expand the household recycling program to all households**. Charging a fee for regular stream waste disposal will offset the cost of this important program.

Sub Theme – Energy: Indicator – Energy Consumption

- We need to **utilize energy efficient building technology** such as smart energy meters.
- **Educate and Incentivize residents** on weatherization and energy conservation.
- Need to **develop real time pricing policy since** we have smart meter capability.
- Need **energy disclosure policies and required audits** for large users.

THEME – Economic Development

Sub Theme – Access: Indicator – Access to Transit

- **Transit service improvements** - Frequency, circulation services/linkages within strategic areas such as the job centers, and **travel time need to be improved** to circumvent congestion and long travel time.
- **Transit accessibility improvements** - Infrastructure such as ramps, sidewalks, bridges over ditches, and sufficient amount of shelters need to be addressed as part of a **complete trips package** to make public transportation safe, feasible, and desirable.
- **Transit coordination** - We need **coordination of public agencies** to plan for improving transit (METRO, Houston Planning Department, Houston Public Works, HGAC, HISD.
- **Transit Planning** - **Transit corridor ordinance has not been utilized effectively** in Houston.

Sub Theme – Demand: Indicator – Vehicle Miles Traveled (VMT)

- **Incentivize housing development near employment areas**.
- **Flex Work program is not being effectively promoted and utilized.**

Sub Theme – Mode: Indicator – Travel Choice

- The **pedestrian and bicycle network should be developed** to complement the bus and rail network as the rail network cannot be as effective without the other modes.
- **Develop technologies such as apps to coordinate transit options** such as bus, rail, and ride share programs.

Houston Sustainable Development Indicators:
A Comprehensive Development Review for Citizens, Analysts and Decision Makers

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HOUSTON
SUSTAINABLE DEVELOPMENT *INDICATORS*:
A Comprehensive Development Review for
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ENVIRONMENTAL DEVELOPMENT
PILLAR OF SUSTAINABILITY

LESTER KING

RICE UNIVERSITY
Shell Center for Sustainability

Houston Sustainable Development Indicators:

A Comprehensive Development Review for Citizens, Analysts and Decision Makers

by

Lester King, PhD, AICP, LEED

Environmental Development Pillar of Sustainability

Theme - Atmosphere
Sub Theme - Air Quality

Indicator - Ambient concentrations of air pollutants

Is it possible to have clean air in Houston given the existence of major chemical processing industries adjacent to the city and the reliance on private cars for transportation? The Houston area has high ambient concentrations of ozone and has traditionally been in violation of one-hour and eight-hour ozone standards (Maret, King, Sexton, & Arscott, 2004). This study does not include air toxics, but Benzene is an issue with recorded levels that commonly exceed 2ppb (Blackburn, 2011).

Sustainability Benefit: The Houston Region is in attainment for some of the regulated National Ambient Air Quality Standards (NAAQS).

Sustainability Issue: Houston is situated next to petrochemical plants, refineries and one of the largest industrial ports in the country. Additionally, Houstonians drive long distances because the City of Houston is large and homes are separated from jobs, services, and daily needs.

The following metrics are used to measure the indicator *Ambient Concentration of Air Pollutants:*

Figure 39: Carbon Monoxide Levels in HGB

Figure 40: Nitrogen Dioxide Levels in HGB

Figure 41: Ozone Levels in HGB

Figure 42: PM 10 Levels in HGB

Figure 43: PM 2.5 Levels in HGB

Figure 44: Lead Levels in HGB

Figure 45: Sulphur Dioxide Levels in HGB
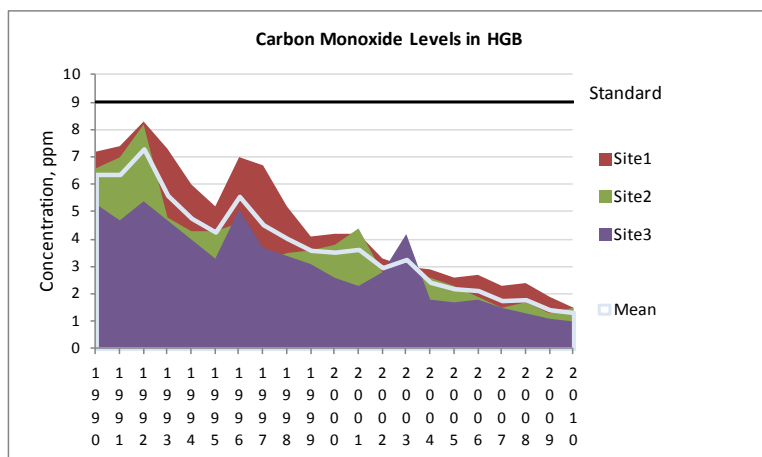
Source: US EPA

Figure 39: Carbon Monoxide Levels in HGB

- Carbon Monoxide levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 9ppm.
- Carbon monoxide levels are decreasing steadily over time.
- The mean level for carbon monoxide in HGB was 1.3 ppm in 2010.

Nitrogen Dioxide Levels in HGB
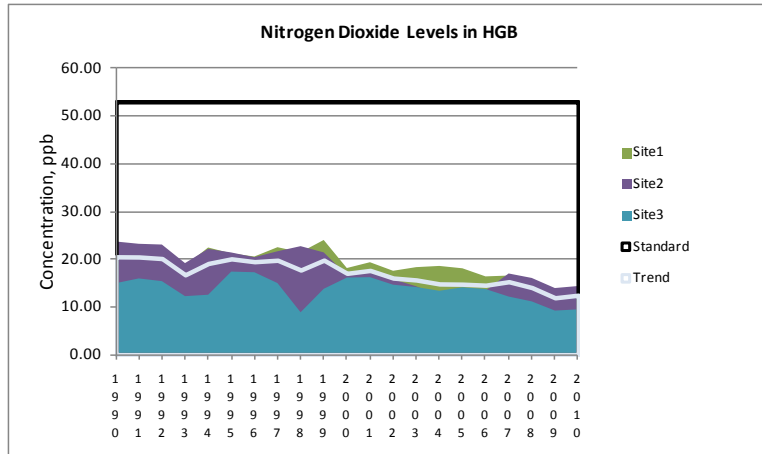
Source: US EPA

Figure 40: Nitrogen Dioxide Levels in HGB

- Nitrogen Dioxide levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 53ppb.
- Nitrogen dioxide levels are decreasing at all three of the monitors used in this analysis.
- The mean level for nitrogen dioxide in HGB was 12.42ppb in 2010.
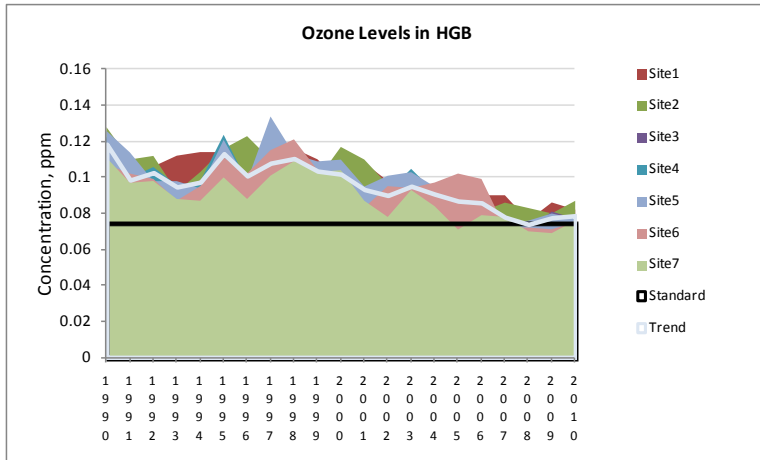
Source: US EPA

Figure 41: Ozone Levels in HGB

- Although ozone levels have been generally decreasing over time, the HGB region continues to exceed the national ambient standard of 0.075ppm.
- In 2010 Houston recorded a mean ozone level of 0.079ppm; which was the annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years.
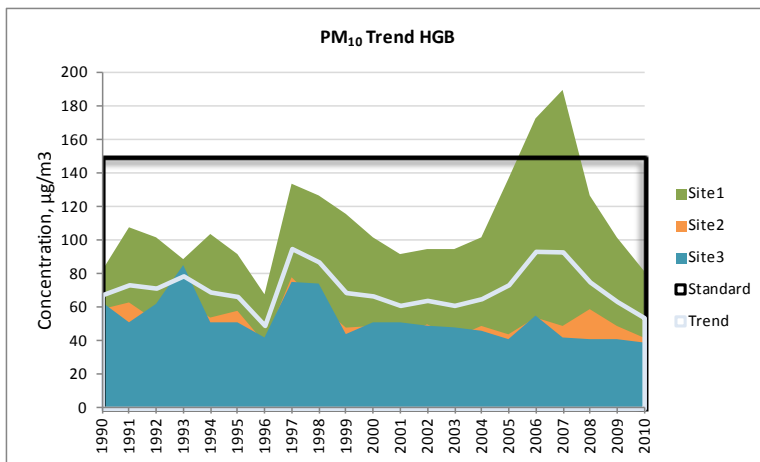
Source: US EPA

Figure 42: PM 10 Levels in HGB

- Particulate Matter (PM_{10}) levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 150 $\mu g/m^3$ (PM10 standard).

- PM_{10} levels are fluctuating at all three of the monitors used in this analysis.
- The mean level for PM_{10} in HGB was 54μg/m^3 in 2010.

PM$_{2.5}$ Trend HGB

Concentration, μg/m3

2	2	2	2	2	2	2	2	2	2	2
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0	1	2	3	4	5	6	7	8	9	0

Legend: Site1, Site2, Site3, Standard, Trend
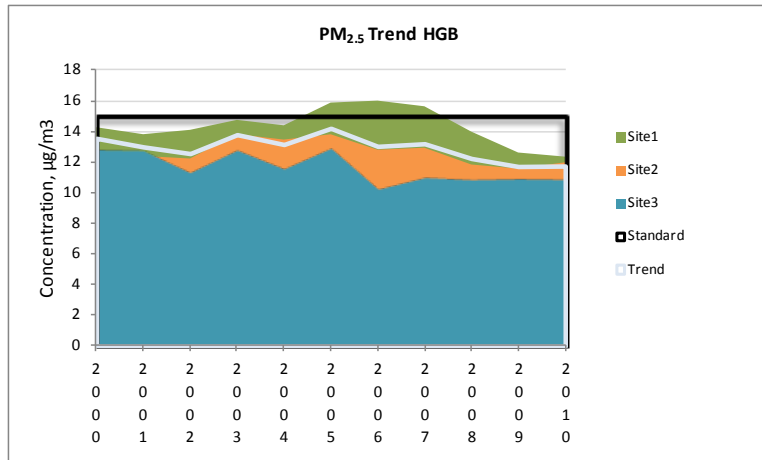
Source: US EPA

Figure 43: PM 2.5 Levels in HGB

- Particulate Matter (PM$_{2.5}$) levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 15 μg/m^3.
- Particulate matter (PM$_{2.5}$) levels are decreasing at all three of the monitors used in this analysis.
- The mean level for particulate matter (PM$_{2.5}$) in HGB was 11.7 μg/m^3 in 2010.
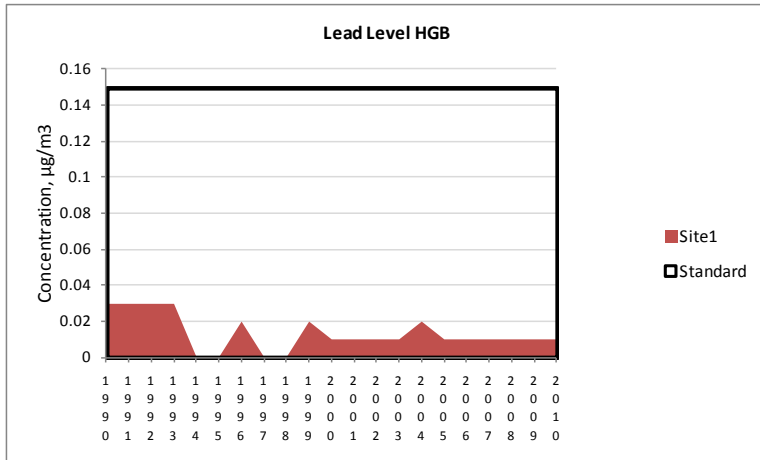
Source: US EPA

Figure 44: Lead Levels in HGB

- Lead levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 0.15 $\mu g/m^3$.
- Lead levels are fluctuating at the one monitor used in this analysis.
- The mean level for Lead in HGB was 0.01 $\mu g/m^3$ in 2010.
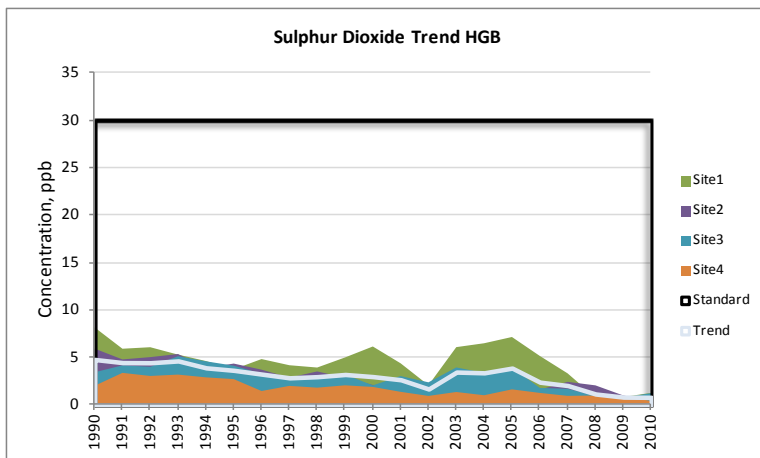
Source: US EPA

Figure 45: Sulphur Dioxide Levels in HGB

- Sulphur Dioxide levels in the Houston-Galveston-Brazoria (HGB) region are below the national ambient air quality standard of 75ppb.
- Sulphur dioxide levels are gradually decreasing at all four of the monitors used in this analysis.
- The mean level for sulphur dioxide in HGB was 0.8ppb in 2010.

Theme - Atmosphere
Sub Theme - Climate Change

Indicator - Greenhouse Gas Emissions

City of Houston municipal operations including water treatment and street lighting generates approximately 2% of the GHG emissions in Harris County with 888,310 tons of emissions, compared with 44,531,660 tons for the county (Environmental Protection Agency, 2011; Gurney et.al., 2009). Using analyses of per unit of land area, cities generate a large amount of greenhouse gas emissions. However, on a per capita basis people who live in the city generate less CO_2 than those outside of the city (Farr, 2008; Glaeser, 2011; Glaeser, 2011). How do we balance the need to fund and build new roads, and support policies for population growth with the need to reduce GHG emissions? One of the most challenging sustainability issues for Houston will be the reduction of CO_2 emissions (Blackburn, 2011).

Sustainability Benefit: There have been major reductions in CO_2 emissions in the Industrial sector between 2000 and 2008 in Harris County.

Sustainability Issue: Electricity Production and On-road sources of emissions are increasingly a challenge for CO_2 reductions in Harris County and the Houston metropolitan area.

The following metrics were chosen to measure the indicator *Greenhouse Gas Emissions:*
Figure 46: Houston MSA CO2 Emissions 2000
Figure 47: Houston MSA CO_2 Emissions 2008
Figure 48: Harris County CO2 Emissions '00-'08
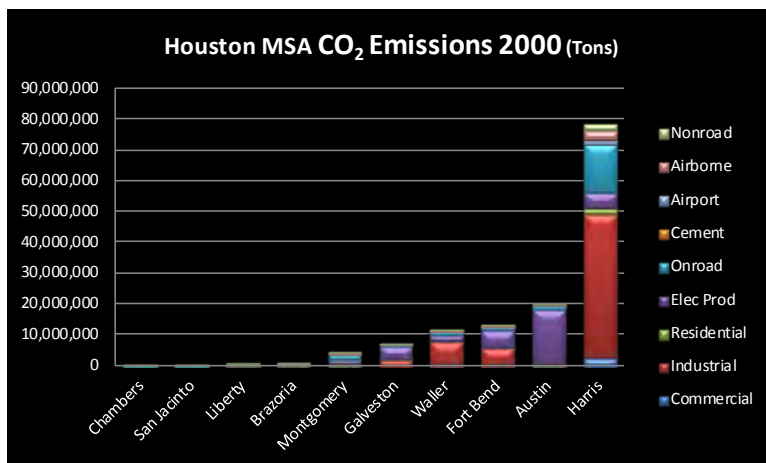
Source Gurney et.al (2009)

Figure 46: Houston MSA CO$_2$ Emissions 2000

- In 2000, the total amount of CO_2 emissions produced in Harris County was 78,619,538 tons.
- Harris County led in terms of CO_2 production by about 4 times the next highest CO_2 producing county.
- In order of descending levels the top CO_2 producing counties following Harris County were; Austin, Fort Bend, Waller, Galveston, Montgomery, Brazoria, Liberty, San Jacinto and Chambers.
- In 2000, the industrial sector emitted more CO_2 than any other sector. On-road mobile sources in Harris County emitted the next highest amount of CO_2.
- Harris County industrial CO_2 emissions were more than the total emissions in every other county in the Houston MSA.
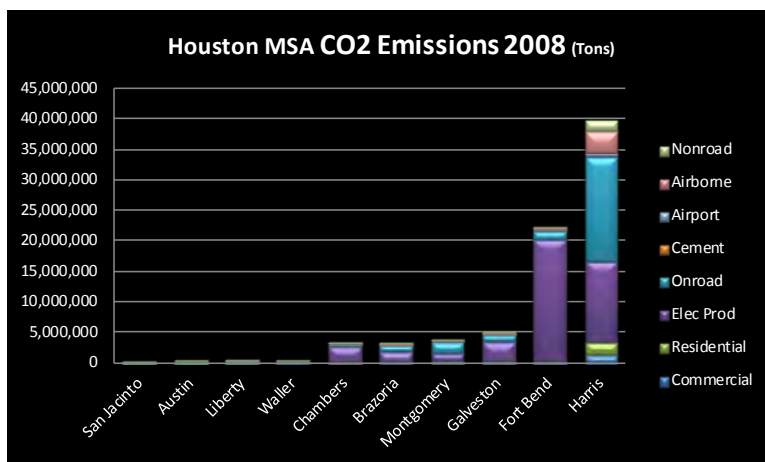
Source Gurney et.al (2009)

Figure 47: Houston MSA CO$_2$ Emissions 2008

- The above figure excludes industrial CO_2 emissions Harris County due to data inconsistencies from the source.
- With industrial CO_2 emissions removed, Harris County still led all the regions in the Houston metropolitan area.

Harris County CO$_2$ Emissions 2000 - 2008 (Tons)
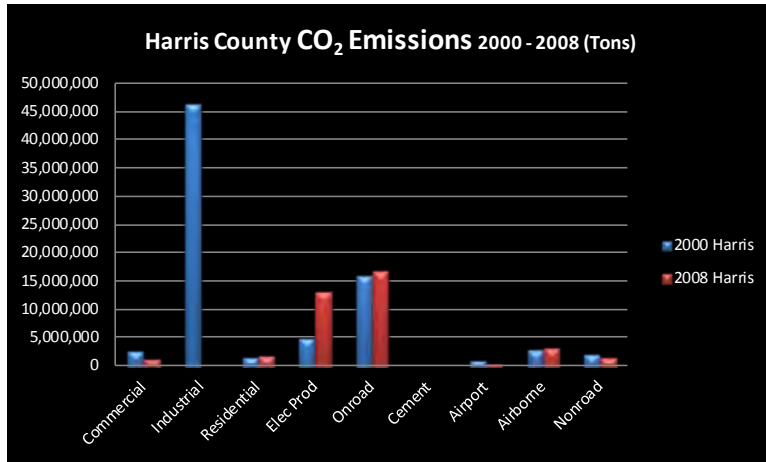
Source Gurney et.al (2009)

Figure 48: Harris County CO2 Emissions '00-'08

- Industrial emission for Harris County far exceeds other emission sources.
- Commercial, airport, and non-road mobile sources (eg. Trains, barge traffic etc.) had reductions in CO2 emissions between 2000 and 2008.
- Electricity production had the highest increase in CO2 emissions, with a change from 5,047,991 tons to 13,283,754 tons between 2000 and 2008 respectively.

Theme - Freshwater
Sub Theme - Water Quality

Indicator - Water Pollution

There have been many improvements in the clean-up of **water pollution** and the safety of drinking water via sewage treatment plants and water purification. The primary focus has shifted from municipal and industrial dischargers to nonpoint source pollution. Approximately 60% to 70% of the water bodies in the country are impaired because of nonpoint sources (Randolph, 2004). Most streams and bayous in Houston violate the standard for bacteria possibly due to the large number of wastewater treatment plants that discharge into waterways (Blackburn, 2011).

Research shows that several types of pollutants are not removed with traditional biological treatment technology. These include anti-depressants, estrogen-containing compounds, and sophisticated chemicals used in soaps.

Sustainability Benefit: The City of Houston is in attainment for all known federal standards for drinking water quality.

Sustainability Issue: The process of using exposed surface water and treating it to drinking quality standards increases the likelihood that users may become exposed to contaminants due to system errors. Source protection of reservoirs should be priority. Houston's drinking water was reported to contain and was treated for 46 chemical contaminants between 2004-2008, including Benzene, Atrazine, Acetone and Dibromochloromethane (Environmental Working Group, 2009). There are no federal standards for emerging contaminants from pharmaceuticals, pesticides, waterborne pathogens or biological toxins.

The following metrics were chosen to measure the indicator *Water Pollution:*
Figure 49: COH Drinking Water Quality 2000-2010

City of Houston **Drinking Water Quality 2000 - 2010**

Source: City of Houston Annual Drinking Water Quality Reports 2000, 2010
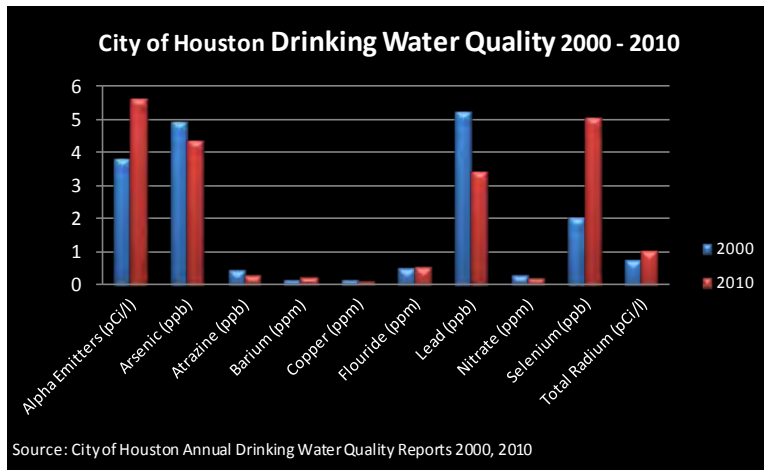
Figure 49: COH Drinking Water Quality 2000-2010

- This figure shows that levels of contaminants generally decreased between 2000 and 2010, with the exception of Alpha Emitters, Barium, Flouride, Selenium, and Radium.
- All chemicals reported were below the Maximum Contaminant Level (MCL) set by the EPA.

Theme - Freshwater

Sub Theme - Water Demand

Indicator - Water Use

In 2000 and 2006 the City of Houston Municipal **water use** was 347,947 and 346,393 acre-feet respectively. Harris County excluding Houston uses approximately 250,000 acre-feet per year for municipal purposes. Dow Chemical Company and Reliant Energy Company hold fresh water permits in the region in the amounts of 321,856 and 166, 238 acre-feet per year respectively. Four industrial companies, including Dow and Reliant, which hold manufacturing water rights, are dedicated almost 670,000 acre-feet per year of the region's water supply. This is in addition to another 580,000 acre-feet sold to other manufacturing companies in 2006. The total municipal water demand for of Region H was 865,966 acre-feet in 2006 (Region H Water Planning Group, 2010). These three users constitute three of the largest municipal and industrial users in the region. The region consists of all or part of 15 counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, Walker and Waller.

Sustainability Benefit: Water use per capita has decreased over time.

Sustainability Issue: Large quantities of water, treated to drinking standards, is used for lawn irrigation in Houston.

The following metrics were chosen to measure the indicator *Water Use*:
Figure 50: Water Use per Capita
Figure 51: Harris County Water Demand
Figure 52: Harris County and Houston Municipal Water Demand

Source: Texas Water Development Board; Calculation by Lester King, PhD.
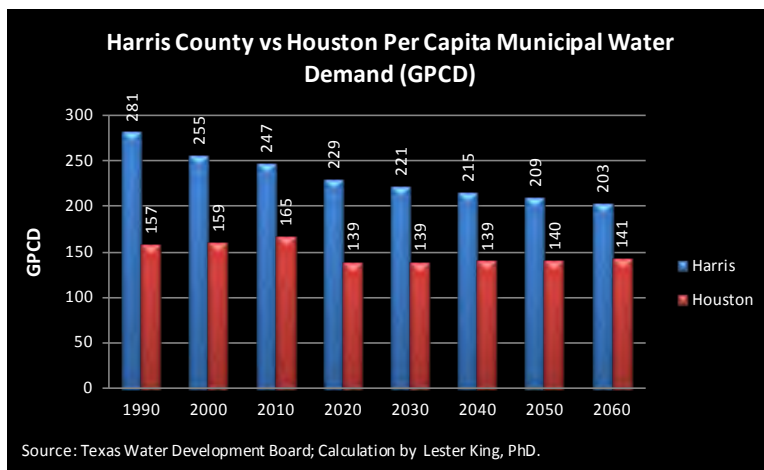
Figure 50: Water Use per Capita

- In 1990 the total amount of municipal water used was 286,550 acre feet of water (157 gallons per capita per day (GPCD)) in the City of Houston. In 2000 347,947 acre feet of water (159 GPCD). In 2010 389,082 acre feet (165 GPCD).
- The projections for 2020 to 2060 estimate water demand will be reduced to 139 GPCD for 2020 – 2040, and then increase by one GPCD between 2050 and 2060.
- The projected water demand in acre feet was extracted from the 2011 Regional Water Plan. The population projection used in that analysis was a linear projection based on 1990 – 2010 census data. This projection is not consistent with intercensal data and may need to be addressed by the Region H Water planning group.

Harris County Water Demand by User Groups 1990 - 2060

Source: Texas Water Development Board
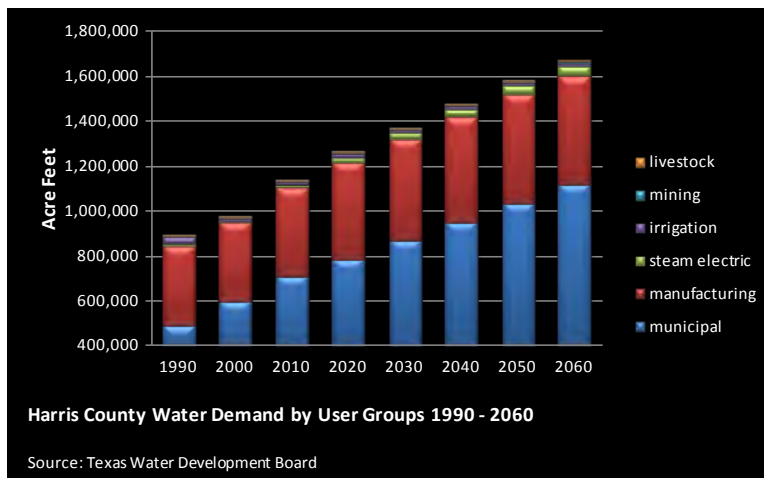
Figure 51: Harris County Water Demand

- Municipal and manufacturing users constitute the largest water user groups in Harris County. Other water user groups such as livestock, mining, irrigation for agriculture, and electricity production use less water.
- Manufacturing demand will remain roughly the same over the next few decades, municipal demand will double over 2000 levels by 2060. By 2060 the municipal water demand will be 1,119,592 acre feet per year.
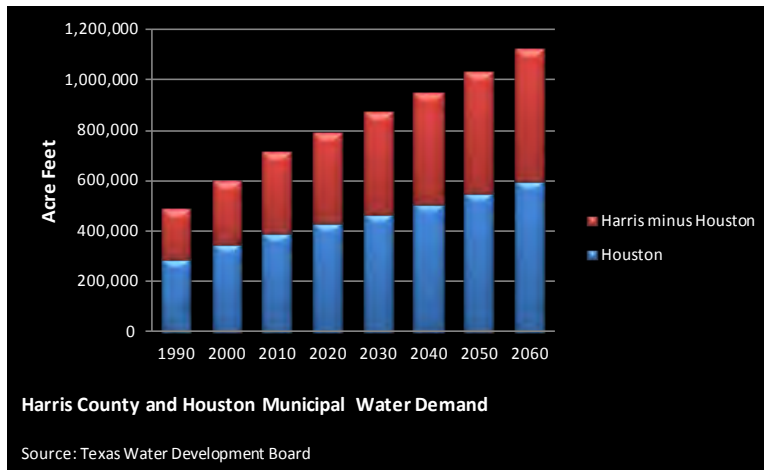
Figure 52: Harris County and Houston Municipal Water Demand

- More municipal water is used within the Houston city limits than in the rest of Harris County.
- In 2010 City of Houston municipal water demand was 389,082 acre feet and for Harris County, outside of Houston, was 320,218 acre feet.

Theme - Freshwater
Sub Theme - Water Resources

Indicator - Water Availability

Water resource planning for the City of Houston is conducted at the regional level by state mandate. Houston is in the Region H water planning group, which is one of 16 regional water planning districts in the state that develops water plans every 5 years. Region H is composed of fifteen counties in southeast Texas and includes the San Jacinto River basin, and the lower reaches of the Brazos and Trinity River basins. Region H contains two thirds of all U.S. petrochemical production and almost one third of the petrochemical industries in the country. These industries consumer large amounts of water. Population is projected to grow from 6 million in 2010 to 11.3 million in 2060. Water demand is projected to grow from 2.38 million acre-feet per year in 2010 to 3.52 million acre-feet per year by 2060. Almost half of the total water demand in the region is from Harris County. The City of Houston is the water provider for Harris County and portions of seven surrounding counties (Region H Water Planning Group, 2010).

Water availability is important for our present daily personal and economic development needs. It is also important to the natural environment, since several ecologies depend on regular stream flows. For example, stream flows into Galveston and contiguous estuaries, significantly influences these ecosystems. In 2011, the City of Houston agreed to dedicate approximately 300,000 acre feet of treated sewage return from Buffalo Bayou to Galveston Bay (Blackburn, 2011).

Sustainability Benefit: We have the financial resources necessary to invest in infrastructure to deliver water from new sources to our city. The regional water plan identifies $12 billion in capital costs for water planning strategies (Region H Water Planning Group, 2010).

Sustainability Issue: We are dependent on surface water sources since land subsidence from groundwater extraction is an issue (Hight, Anderson, Robinson, & Wallace, 2011). The City of Houston is responsible for providing water to surrounding cities. The issue here is that with the city acting both as consumer and commercial supplier, there may be the complication of reducing demand for this scarce resource and increasing sales income.

The following metrics were chosen to measure the indicator *Water Availability:*
Figure 53: Houston Region Water Supply
Figure 54: Houston Region Water Demand vs Supply
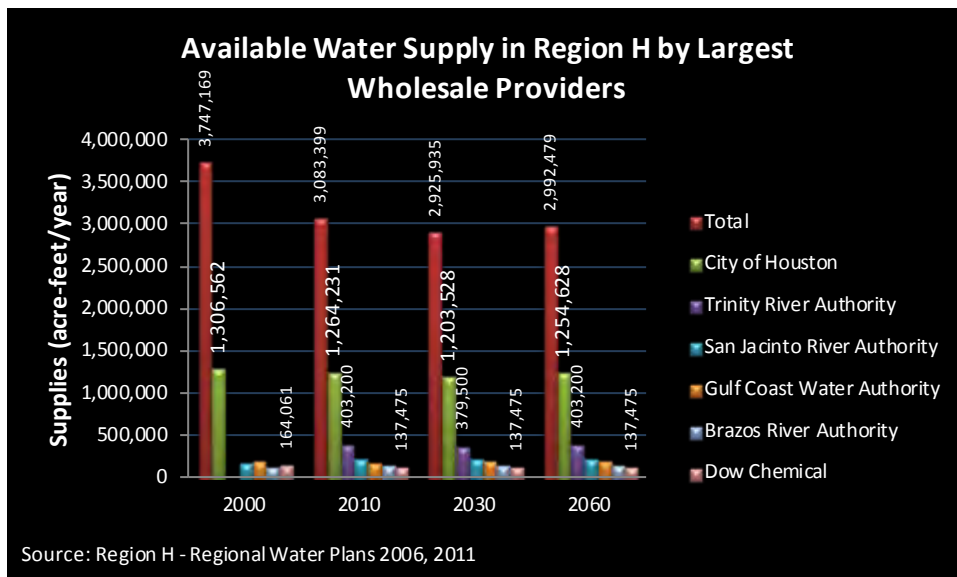
Figure 53: Houston Region Water Supply

- The City of Houston is the largest wholesale water provider in the region and has an estimated 1.8 billion gallons of water per day of availability (Chang, 2012). This is a little less than half of the total available water supplies in the region.
- There are 24 other water providers in the region who have 2,440,607 acre-feet/year of water.
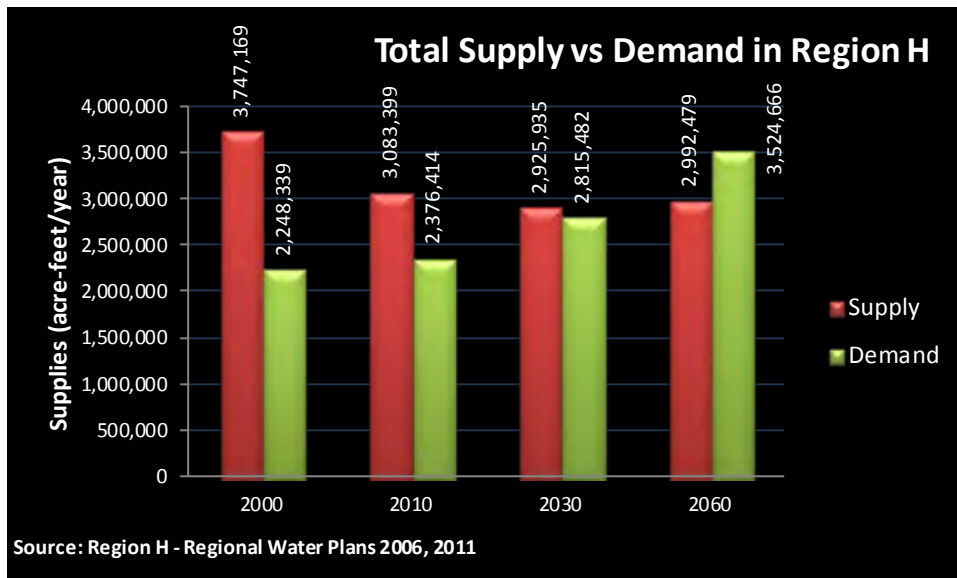
Figure 54: Houston Region Water Demand vs Supply

- The total supply of water in the Houston region was 3 million acre-feet/ year in 2010. This supply will drop slightly below 3 million acre-feet/year by 2060. At the same time the demand is expected to increase to 3.5 million acre-feet/year so there is a shortfall in the region for water availability in 2060.
- Over time water demand in the region is increasing, while water supply is decreasing. The regional water plan identifies $12 billion in capital costs for necessary water planning strategies (Region H Water Planning Group, 2010).

Theme - Land

Sub Theme - Flooding

Indicator – Flood Plain Expansion

Flooding is a major issue in the city and the floodplain is increasing as a result of increased development. In Harris county, the floodplain increased by 65 square miles between 1996 and 2007 (Blackburn, 2011). According to the Harris County Flood Control District (HCFCD), 65% of the area in Harris County that flooded during Tropical Storm Allison was outside of the mapped regulatory floodplain (Harris County Flood Control District, 2004).

Sustainability Benefit: The delineation of the 100-year floodplain is a good estimate to identify areas at risk of flooding.

Sustainability Issue: Increasing the amount of impervious paving in the city also increases the amount of stormwater runoff and hence exacerbates flooding.

The following metrics are used to measure the indicator *Flood Plain Expansion***:**
Houston floodplain expansion

Houston Flood Plain Expansion 2000 - 2012

Legend
— FREEWAYS
▢ 100 Year Flood Zone 2000
▢ 100 Year Flood Zone 2012
■ City of Houston
▢ Harris County 100 Year Flood Zone

0   5   10   20 Miles

Source: Harris County Flood Control District. Map created by Lester King, PhD.
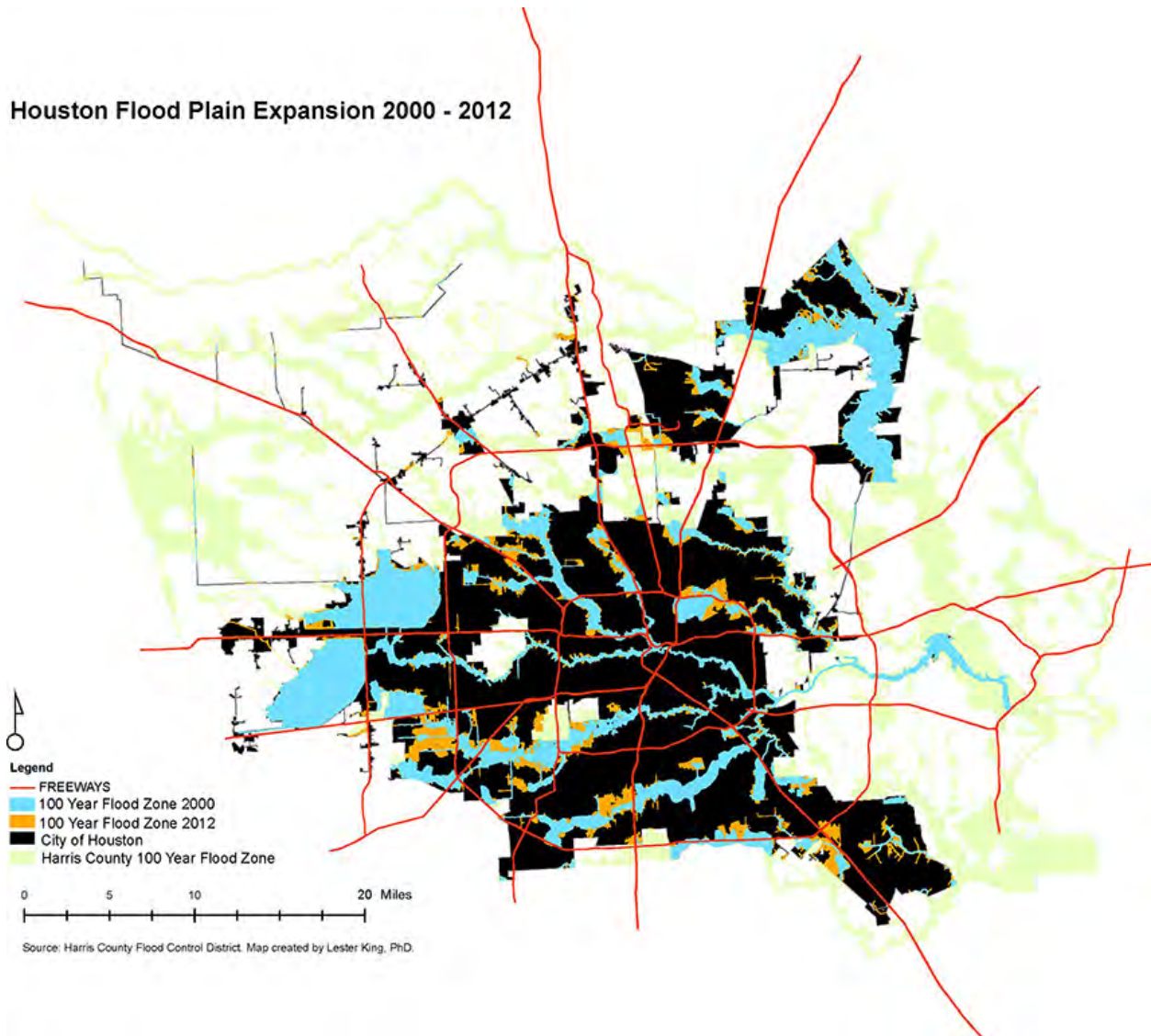
Figure 55: Houston floodplain expansion

- The 100 year floodplain expanded from 24% to 25.5% of the City of Houston, between 2000 and 2012.
- The 100 year floodplain expanded by 11,375 acres (18 sq mi) between 2000 and 2012.
- An estimated 17% (364,497) of Houstonians live within 25 feet of the 100 year floodplain.
- An estimated 148,853 housing units are within 25 feet of the 100 year floodplain. Using the Census 2010 median housing value estimate of $124,700 in Houston, this gives the estimated value of $18.5 billion for housing units within 25 feet of the 100 year floodplain.

Theme - Land
Sub Theme - Land Cover

Indicator - Land Cover Change

During the period 2000 to 2025, if development practices remain the same, the United States is expected to lose 7 million acres of farmland and 7 million acres of fragile lands to real estate development (Burchell, Downs, McCann, & Mukherji, 2005). **Land cover** is constantly changing in the city and surrounding region. Despite the traditional definition of Houston as a sprawling city because of its large land area, Houston has more recently been described as an 'Opportunity City' because it has an openness to outsiders; a diverse and entrepreneurial economy; a friendly business climate; commitment to transportation infrastructure; and a positive attitude towards growth (Kotkin, 2007). The Houston transportation region is composed of 13 counties. In a 2005 analysis of ecosystems in the 8 most central counties, there has been a loss of up to 40% of some ecosystems to development. The analysis shows there has been a loss of 25% of Big Thicket, 14% of Coastal Marshes, 21% of Columbia Bottomlands, 31% of Piney Woods, 16% of Post Oak Savannah, 40% of Coastal Prairie, and 11% of Trinity Bottomlands ecosystems (Blackburn, 2011).

Sustainability Benefit: Houston is a large city capable of absorbing a lot of growth and development.

Sustainability Issue: Growth and development does not maximize land utility since most development in the city has single story buildings. As a result more open space and natural areas are developed and commuting distances increased.

The following metrics were used to measure Land Cover Change:
Figure 56: City of Houston Land Cover 1992
Figure 57: City of Houston Land Cover 2001
Figure 58: City of Houston Land Cover 2006
Figure 59: Houston Land Cover 1992 – 2006
Figure 60: Houston Land Cover 1992 - 2006 (Urban Not Shown)
Figure 61: Houston Land Cover 2001 – 2006
Figure 62: Houston Land Cover Change 2001 - 2006 Percent Change

City of Houston Land Cover 1992

Map Created by: Lester King, PhD
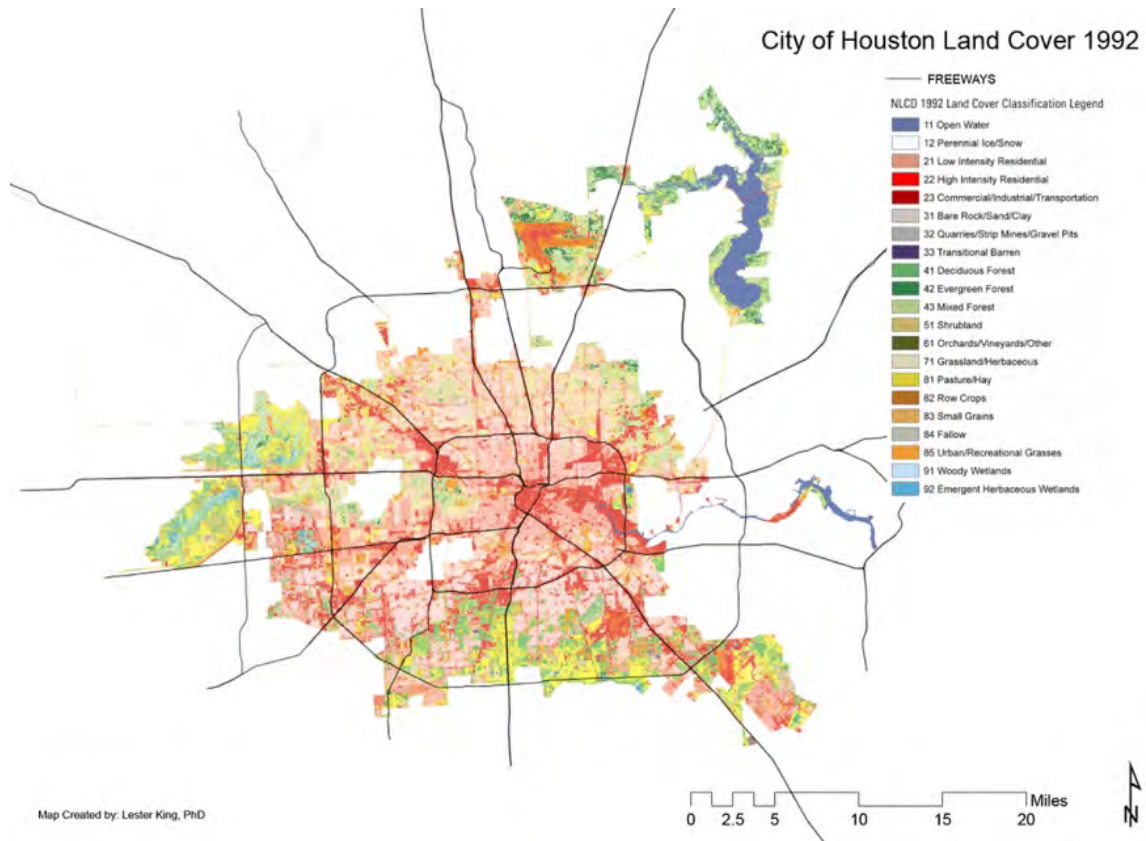
Source: US Department of the Interior – USGS

Figure 56: City of Houston Land Cover 1992

- The map shows land cover complexity in Houston.
- There are several areas to the south, north-east and west of the city with undeveloped land but most of the City is covered by low-intensity residential uses.

City of Houston Land Cover 2001

NLCD Land Cover Classification Legend
- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

Map Created by: Lester King, PhD

Source: US Department of the Interior – USGS

Figure 57: City of Houston Land Cover 2001

- This map shows that most of the City of Houston is covered with low and medium intensity development. Low intensity areas are described as areas with a mixture of constructed materials and vegetation and with impervious surfaces covering 20 – 49% of total land cover. Medium intensity areas have 50 – 79% impervious surface cover.
- Single family housing units are allocated to either the low-intensity or the medium-intensity areas.

City of Houston Land Cover 2006

Map Created by: Lester King, PhD
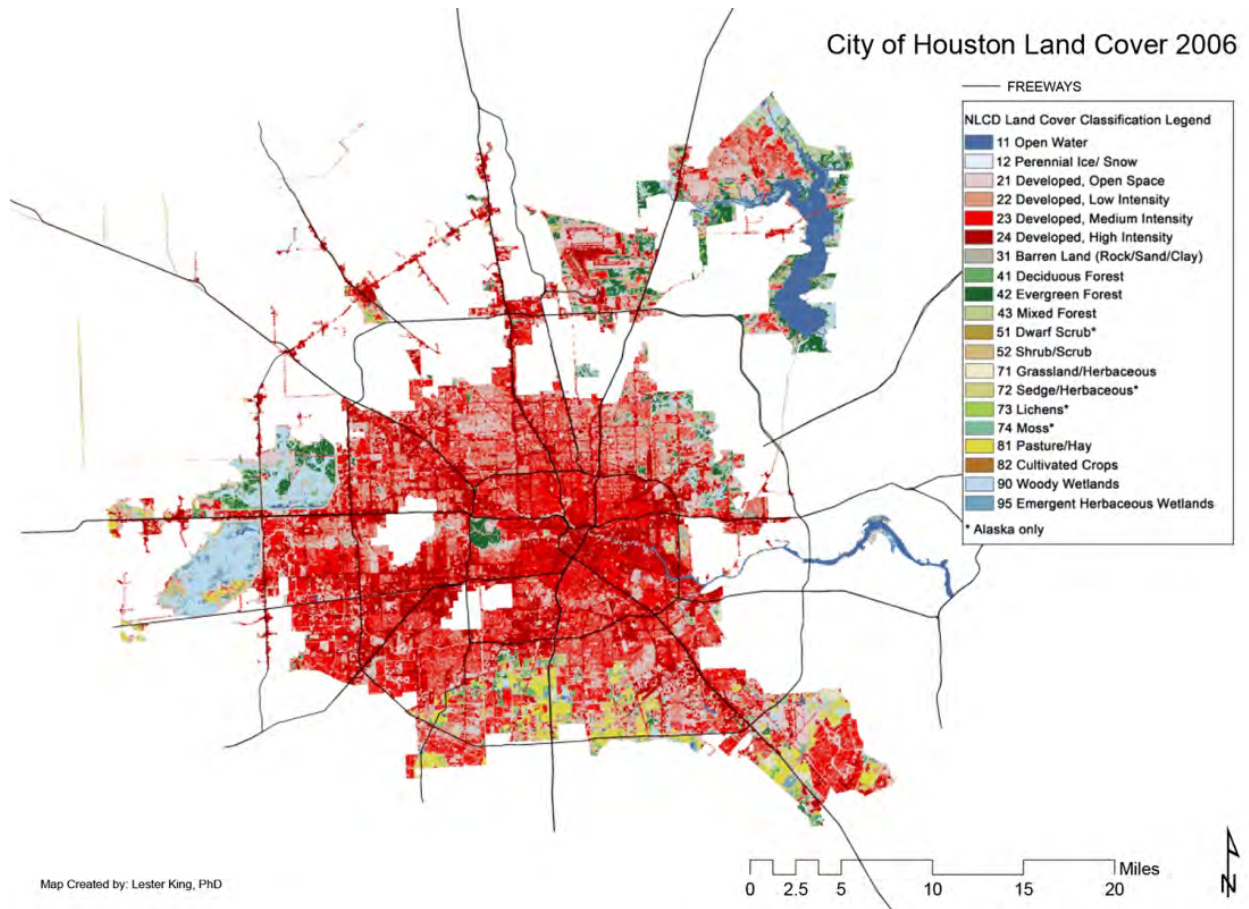
Source: US Department of the Interior – USGS

Figure 58: City of Houston Land Cover 2006

- The 2006 land cover map is almost identical to the 2001 land cover map except it shows the newly annexed areas to the north-west and west of the city as being areas of predominately high to medium intensity development.
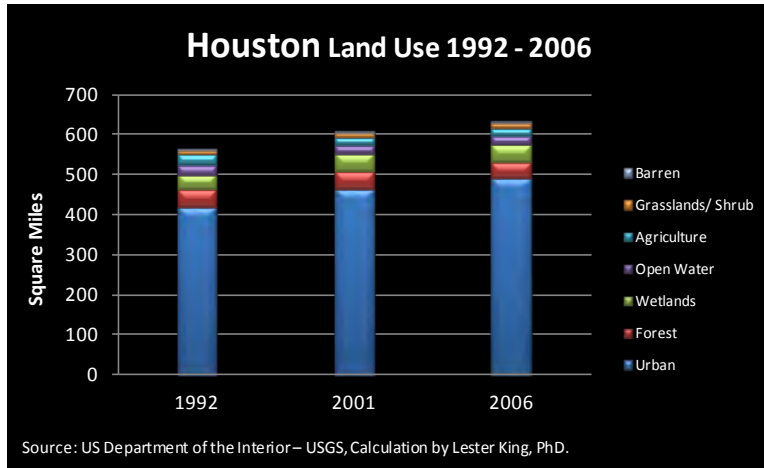
Figure 59: Houston Land Cover 1992 – 2006

- Data classification of the land cover in Houston shows the degree of land cover change between 1992 and 2006. All land uses remains virtually the same over time except for urban land use. Urban is here defined as all developed areas with constructed materials.
- Wetlands and forests actually constitute the next largest land coverage types in the City of Houston.
- 78% of Houston was urbanized in 2010 (491 acres).
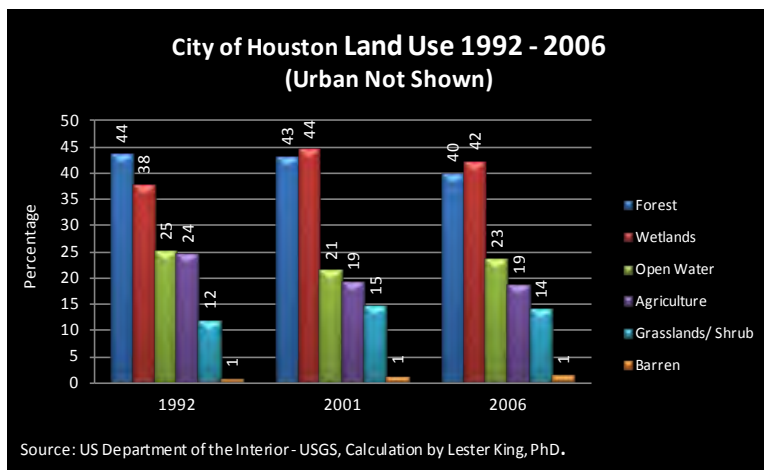
Figure 60: Houston Land Cover 1992 - 2006 (Urban Not Shown)

- The above map shows a comparison of smaller land coverage types in Houston excluding urban land use.

- This figure shows that Forests were the dominant type in 1992. This land use then gave way to Wetlands which increased by 2001 to be the second most common type of land with urban land being dominant.
- Agricultural land is decreasing in the City of Houston. It has decreased at a very slow rate through, between 2001 and 2006.

City of Houston Land Use 2001 - 2006
Detailed Developed Classes

Source: US Department of the Interior-USGS, Calculation by Author
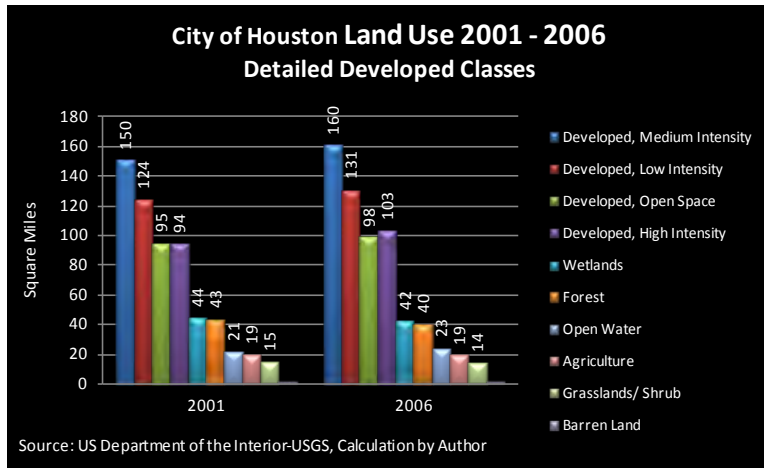
Figure 61: Houston Land Cover 2001 – 2006

- Between 2001 and 2006, medium Intensity development was the highest form of land coverage. Medium Intensity development increased from 150 square miles to 160 square miles.
- High intensity development and developed open space changed little between 2001 and 2006.
- 291 acres was medium to low intensity development in 2006 (46%).
- High intensity development was 16% of the urbanized area in 2006 (103 acres).

City of Houston Land Cover Change
Percent Changed

Source: US Bureau of the Interior-USGS, Calculation by Author
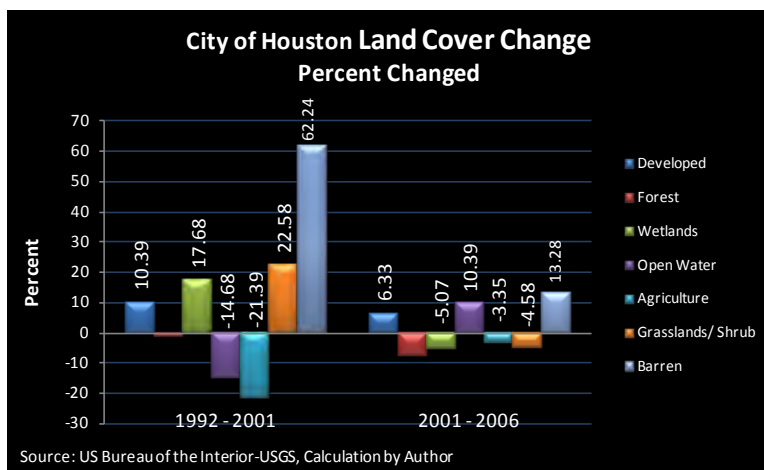
Figure 62: Houston Land Cover Change 2001 - 2006 Percent Change

- Between 1992 and 2001 there was greater change in land cover than between 2001 and 2006.
- The largest changes between 1992 and 2001 were: a 62% increase in barren land cover; a 22% increase in grasslands; and a 21% decrease in agricultural land. Developed land increased by 10%
- The largest change between 2001 and 2006 was a 13% increase in barren land and a 3% decrease in agricultural land.

Theme - Land
Sub Theme - Classification

Indicator - Jobs/ Housing Balance

Sprawl can be described as the separated spread-out development practice that has dominated suburban development over the last 60 years. The **Jobs/ Housing balance** is a focus on the supply of housing in proximity to jobs. The ideal Jobs/Housing balance is one that offers access to various types of housing such as single family, duplexes, and multifamily housing in walking distance to jobs. The Jobs/Housing balance alludes to the importance of mixed-use developments where access to schools, services, entertainment, jobs and housing is made possible (Burchell, Downs, McCann, & Mukherji, 2005). For sustainable development, should companies be encouraged to locate in existing business centers or should we let the market decide? In a survey of Harris County residents in 2010, 80% called for redevelopment of older urban areas for mixed use development (Klineberg, 2010). However in a 2005 survey, Anglos preferred neighborhoods that do not have high percentages of African American or Hispanic people (Klineberg, 2005) This complicates the location theory of maximizing income to find housing close to jobs and factors most important in individuals choice of housing location. It also explains why some inner city neighborhoods such as the Houston Third Ward and parts of the Fifth Ward still have large supplies of vacant and underused property, despite their close proximity to the central business district.

Sustainability Benefit: Houston has a very efficient freeway system which connects most areas of the city to employment centers very efficiently.

Sustainability Issue: Less than 25% of Houstonians live within a quarter mile of high density business centers.

The following metric were used to measure *Job / Housing Balance:*

Figure 63: Houston Business Centers
Figure 64: Houston Jobs/ Housing Balance
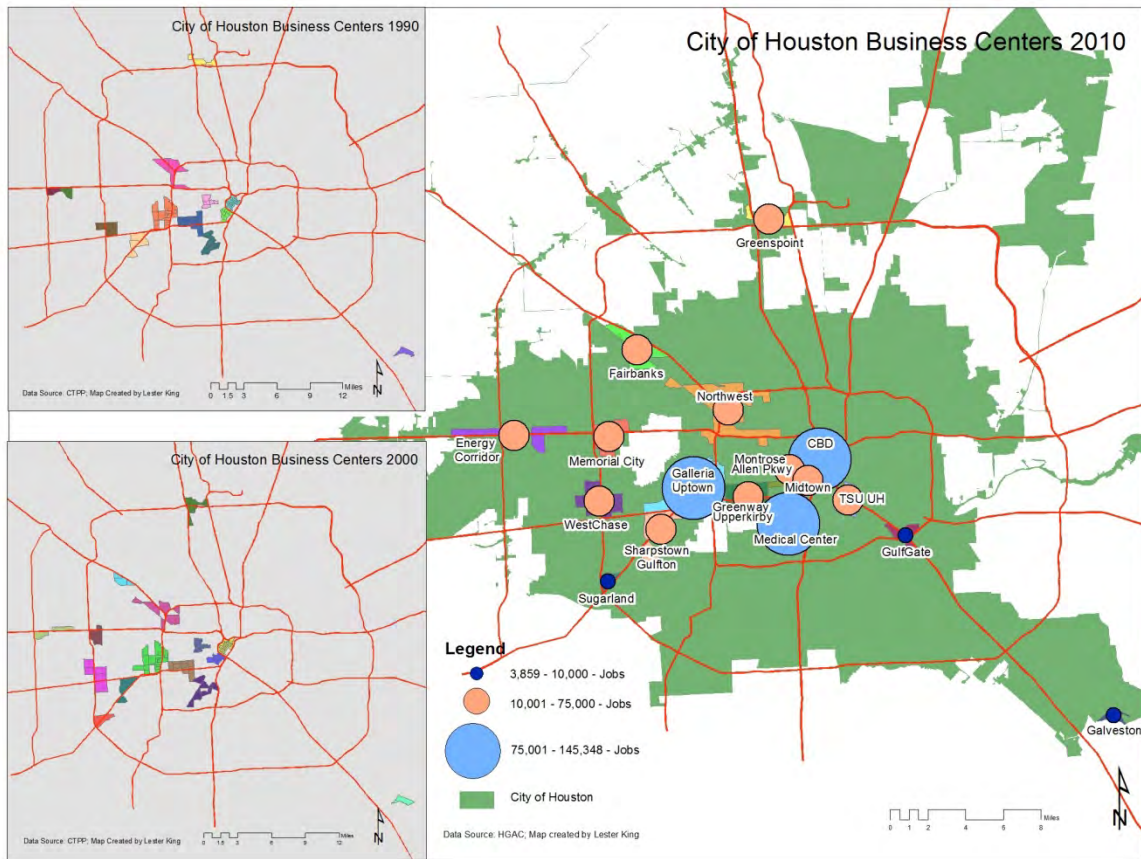
Figure 63: Houston Business Centers

- This map shows the location of business centers in Houston from 1990 – 2000. These business centers are defined primarily as places with a high density of jobs (Greater than 10 per acre within transit analysis zones (TAZs) and clusters of such high density TAZs with more than 10,000 jobs). In most cases the actual boundaries of the business center will be larger than depicted and contain more jobs than reported. This analysis only reports jobs in the high density areas.
- In 1990 there were 12 business centers; in 2000 there were 15 business centers; in 2010 there were 17 business centers (Due to reclassification of TAZs by HGAC and based on their 2010 job projection numbers, Sugarland, Gulfgate, and Galveston show less than 10,000 jobs in the areas selected).
- Downtown, the Galleria, and the Medical Center show the highest concentration of jobs in the City of Houston with more than 75,000 jobs.
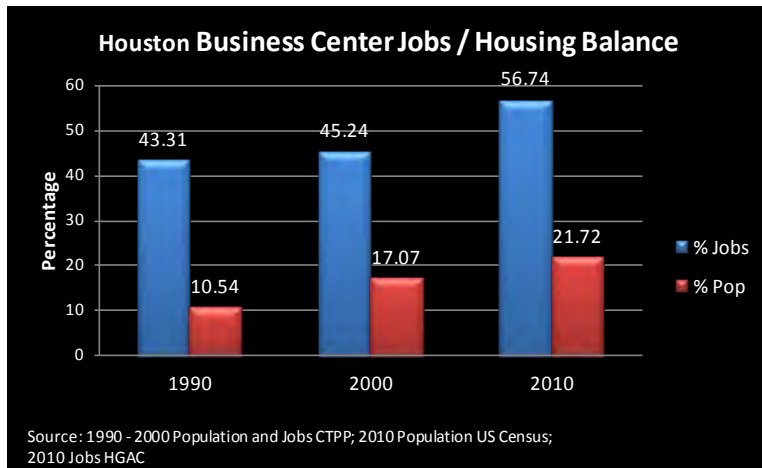
Figure 64: Houston Jobs/ Housing Balance

- The percentage of persons and jobs located close to high density business centers in Houston is increasing.
- Between 1990 and 2010, the percentage of jobs located in high density business centers increased by 13%.
- From 1990 to 2010 the percentage of persons that reside within a quarter mile of high density business centers more than doubled from 10% to 22%.
- Less than 25% of Houstonians live within a quarter mile of high density business centers.

Environmental Development Policy Recommendations

THEME – Atmosphere

Sub Theme – Air Quality: Indicator – Ambient Pollutants

- **Expand the air quality monitoring network**.
- **A Gulf Coast Mobility Plan is needed** for coastal cities along the gulf since the efficient delivery of logistics reduces air pollution generated from this sector.

Sub Theme – Climate Change: Indicator – Greenhouse Gas Emissions

- **A Climate Vulnerability Assessment and Adaptation plan is needed** for the entire city and not just city operations.

THEME – Fresh Water

Sub Theme – Water Quality: Indicator – Water Pollution

- **Expanded monitoring and enforcement of the waste water treatment plants.** Present monitoring of the discharges into surface streams is unsatisfactory.
- The City of Houston meets all known federal standards for drinking water treatment. However **emerging and unregulated contaminants are not addressed under federal standards** and as we continue to rely more heavily on surface water risks of exposure are increasing.

Sub Theme – Water Demand: Indicator – Water Use

- A strong **Drought Contingency Plan** is needed and **public education campaign.**
- Need **better assessment of end user water demand** such as landscape irrigation.
- Need to establish a city **Water Vulnerability Tax**.

Sub Theme – Water Resources: Indicator – Water Availability

- Our dependency on surface water increases our vulnerability to drought.

THEME – Land

Sub Theme – Flooding: Indicator – Floodplain Expansion

- Need to accelerate **conversion of property in floodplains to open space**.
- **Eliminate development in the floodplain.**

Sub Theme – Land Cover: Indicator – Land Cover Change

- **Stronger policies for green space acquisition are needed.**

Sub Theme – Land Classification: Indicator – Jobs/Housing Balance

- **Development codes are not robust enough to increase livability** in the city.
- The development codes should include elimination of minimum lot sizes or setbacks; complete streets; encouraging housing closer to job centers etc.

Houston Sustainable Development Indicators:
A Comprehensive Development Review for Citizens, Analysts and Decision Makers

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HOUSTON
SUSTAINABLE DEVELOPMENT *INDICATORS:*
A Comprehensive Development Review for
Citizens, Analysts and Decision Makers

LESTER KING

Houston Sustainable Development Indicators:

A Comprehensive Development Review for Citizens, Analysts and Decision Makers

by

Lester King, PhD, AICP, LEED

Conclusion

Houston is the 4th largest city in the country and currently has a national reputation for sprawl, air pollution, and a southern stereotype of 'cowboy culture.' To dispel these notions the City has been engaged in marketing its strengths such as: affordable housing; largest medical center in the world; world-class arts and entertainment venues; home for several sports teams including basketball, soccer, and football. The city has also recently started focusing on marketing livability and sustainability (Radley, 2012; The Economist, 2012). Marketing campaigns are important to generate interest, but more important are the facts necessary to identify areas of improvement for function and aesthetics of the city. The Houston Sustainability Indicators Project (HSI) was designed to generate facts and measure how well Houston is doing in terms of development and to identify areas of improvement as Houston pursues sustainable development. The intrinsic value of a sustainability indicators report, and what separates it from traditional performance reports or adhoc compilations of metrics, is the sustainability themes and topics and the presentation of data in a systematic manner, which reflects the relationships among disparate systems.

The City of Houston is a wealthy city. As such progress towards sustainability is a matter of choices and priorities. The city has a $2.4 billion investment portfolio and assets exceed liabilities by $3.5 billion (City of Houston, 2011). It follows that the degree of unsustainable practices in Houston is directly related to the lack of will to pursue sustainability by residents, business and local leaders. This, in turn, is the result of a lack of information about how the city is developing. This study has found that most of the several indicators analyzed are not included in any public reports.

This sustainability indicators report is meant to be used as the basis for an agenda of livability, greening or sustainable development in Houston. With annual updates, improvements in these indicators would

represent clear progress towards sustainability in Houston. Reductions in indicators present challenges for future generations.

The following summary is a listing of the sustainability indicators by priority. The indicators are listed by the percentage of population impacted. Environmental indicators are listed prominently since indicators like air pollution affect everyone.

Summary Importance and Impact of Sustainability Indicators		
Indicator	**Metrics Description**	**Importance and Impact**
 14. Energy Consumption	Average residential energy consumption per household has increased between 2000 and 2010 from 13,496 kwh to 14,221 kwh. This accounts for 11 million Mwh needed to power Houston homes in 2010. The city administration of Houston uses only 10% of this number and HISD uses 4%.	**100% population affected.** Energy is one of the most important challenges for the Houston region. Due to our torrid summer temperatures we depend on cooling technologies. To get around our city we depend on cars. We also need energy to drive our economy. Deriving energy from coal or petroleum is not as sustainable as integrating natural gas or renewable energy resources. Integration of natural gas into our energy supply is needed. Gas produces 25% less carbon dioxide than petroleum and 50% less carbon dioxide than coal (The Economist, 2012).
 16. Vehicle Miles Travelled	Annual VMT is projected to increase in Houston.	**100% of population affected.** VMT increases per capita demonstrate that there is a sprawl issue in the city. More driving causes more congestion; more pollution; and reduces economic efficiency due to traffic delays.
 18. Ambient concentrations of air pollutants	Houston has attained criteria pollutants under federal standards except for Ozone. The Houston region is in non-attainment for the federal standard for Ozone.	**100% of population affected**. Ozone levels in Houston continue to be above federally mandated standards. This is a major health issue and liability for all Houstonians.

19. Greenhouse Gas Emissions	Private vehicles CO$_2$ emissions are increasing and now constitute the largest source for CO$_2$ emissions in the county.	**100% of population affected**. GHG emissions from private vehicles are an increasing burden. Efficient public transit, such as rail, would greatly reduce dependence on private cars.
21. Water Use	Per capita municipal water use in Houston increased from 159 gallons per day in 2000 to 165 gallons per day in 2010. Unless this trend is reversed, water consumption will increase disproportionally with population growth, a trend that is not sustainable.	**100% of population affected.** Water is essential to life and since there are diverse uses for water, our water supply should reflect that fact. Water suitable for ingestion should not be used to water lawns or wash cars. A city with over 2 million people should have a separate system to provide water for purposes other than drinking. This reduces the overall cost to tax payers since water treatment requires a great deal of energy.
23. Flooding	One quarter of the City of Houston is at risk of flooding.	**17% of the population affected**. Almost 400,000 people live in an area that is at risk of flooding in Houston. The estimated value of Housing units in this area is $18 billion. The City of Houston needs to accelerate buyout for flood prone properties.
20. Water Pollution	Houston water quality monitoring expanded considerably between 2004 and 2011. Additionally, the City of Houston published annual updates of water quality to all residents.	**100% of population affected.** The City of Houston is currently in compliance with all known federal standards for drinking water quality. However there are no federal standards for emerging contaminants from pharmaceuticals, pesticides, waterborne pathogens or biological toxins.
4. Indicator – Income Inequality	Income inequality must be addressed in Houston since the median top 20% earned $140,000; median earnings were $43,000; and the bottom 20% earned a median income of $10,000.	**80% of households earn under twice the median household income in 2010.** There is general awareness that incomes for the majority of workers are not rising commensurate with economic gains. It is not clear what public policy interventions exist for this problem, which affects 80% of the working population.

 25. Jobs / Housing Balance	A higher percentage of jobs are located within business centers, which is good for agglomeration. However only 21% of housing units are located within a quarter mile of business centers. This means that 78% of persons are commuting alone in private autos.	**78% of population affected.** There is a need for more multifamily units located closer to job centers. Developers in Houston have a less regulated market and as a result high building rates. What is needed are design and construction guidelines for building in proximity to job centers. Houston cannot gain sustainability simply by providing cheap housing. What is also needed is well designed developments, which create a sense of place. This is one of the major tenents of a livability agenda.
 17. Travel Choice	A higher percentage of people in Houston were travelling alone using private cars in 2010 than in 2000. In 2000 28% of persons used alternative travel sources. The number dropped to 25% in 2010.	**75% of population affected.** In many cities buses, which use the same road space as cars, are not perceived as a more efficient form of alternative transportation. We need to continue the development of rail in the city. All large major cities have easily accessible rail as an alternative transportation option. In order to assume its position as a major livable city in the United States, Houston will have to more actively develop its rail network.
 8. Accessibility of Public Spaces	44% of the population lives within a quarter mile of a public park. This number needs to increase to ensure accessibility to quality of life in Houston.	**56% of the population affected.** More open space must be added to our parks inventory. This is also a major component of a livability agenda.
 3. Voter Participation	Only 7% of the population voted in the local election of 2011.	**93% of population affected.** The population is not properly engaged and has not prioritized the value of electing city representatives. The management of a city is the business of all citizens. When the general population does not participate, this gives leeway to organized business and lobbying groups, to create a city that meets their needs. A city which meets the needs of business and not its citizens may not be a very livable city. It is in everyone's interest to increase voter participation in the city.

 7. Affordability	30% of Houstonians spent more than 30% of their income on housing in 2010. Since housing in Houston is cheaper than in other parts of the country, this problem may be a result of unemployment or underemployment.	**57% of Households earn below median affordable household income.** Houston is currently marketed as one of the most affordable cities in the country because of the low cost of housing. Incomes must be commensurate with the cost of housing or cheap housing will still be unaffordable.
 9. Food Deserts	36% of the population lives within a Food Desert. That is, they live more than 1 mile from a grocery store or supermarket that sells fresh fruit and vegetables.	**36% of the population affected**. Currently 58% of adults and 39% of children are overweight or obese in the Houston region (Center for Clinical and Translational Sciences, 2012). Not having convenient access to a supermarket that sells fresh fruits and vegetables, means having meals, which may not be as healthy. Location decisions have also determined that some areas such as Houston's Third Ward should not have a major supermarket. Public intervention can help alleviate this issue.
 6. Health Coverage	30% of persons have no health insurance in Houston in 2010. Houston has the largest medical center in the world, and boasts many jobs in this sector. However, access to health insurance in Houston is a problem.	**30% of population affected.** Since health insurance is presently tied to employment in this country, this explains one third of the uninsured in 2010. The other two-thirds are perhaps underemployed persons, whose employers do not offer health insurance; or privately wealthy individuals who choose to pay privately for healthcare services. This is a federal issue, but local governments can help ensure the availability of skills training.
 12. Income	Since per capita income in 2010 ($44,001), was slightly below 2007 levels ($44,872), it is estimated that the 2008 economic recession set us back approximately 3 years.	**29% was the per capita income increase in the Houston MSA in 2010.** Population increased by 26% during that same period and the median household income increased by 21%. Total income is increasing faster than population growth. In historical comparison, the per capita income increased by 70% between 1990 and 2000. Between 2000 and 2010 the economy slowed by half from the previous decade.

2. Education Attainment	There exists an attainment gap between the White student cohort and other student groups. In general all graduation rates have improved. The HISD district graduation rate was 74.3% in 2010.	**25.7% of the population affected**. High school drop outs are not properly prepared for the workforce. They constitute a large percentage of the unemployed and low wage populace. More opportunities are needed for the development of skills training in Houston as an alternative to professional tracks. According to research sponsored by the Greater Houston Partnership, Houston should focus on the development of blue collar jobs to facilitate industrial and manufacturing job growth in this region (Kotkin, 2007).
5. Poverty Rate	The percentage of persons below poverty was 23% (474,346) in 2010. This metric is increasing, which is not a sustainable trend.	**23% of population affected**. Poverty can affect a person due to unforeseen events. Cyclical poverty must be addressed or it continues through generations. This type of poverty may be caused by poor schools, poorly maintained neighborhoods and poor access to services. These problems can be alleviated by improved public services.
10. Employment Status	The unemployment rate for Houston was 10% in 2010. For the white cohort it was 6.2% and for African Americans it was 16.5%. This means disproportionate hiring or employment stability practiced in Houston.	**10% of the population affected**. The unemployment rate may be the sign of a slow economy or improperly trained workforce. Public intervention may occur by the attraction of more businesses to the city or increased skills training for the population. Since high schools in Houston do not have curricula to facilitate blue collar careers, most potential employees in this area have to matriculate through the community college system or learn on the job. This scenario creates a disadvantage for high-school drop-outs who are prevented from enrollment in community colleges due to lack of high-school diploma.
11. Primary Jobs and Green Jobs	Medical jobs in Houston are increasing while industrial jobs are decreasing as an absolute percentage of all jobs. Together, industrial and manufacturing jobs make up 23% of all jobs and are considered primary jobs for Houston. Less than 7% of	**5% Industrial Job loss.** A reduction in industrial job growth is very difficult for the local economy, since these jobs bring new capital into the local economy. Due to the size of the local economy we may be able to replace jobs lost from the industrial sector with jobs in the service sector. However, there has been job growth in

	all jobs in Houston are green jobs.	the medical sector. Houston must continue development of jobs in the medical sector.
15. Access to Transit	As of 2010, 78.5% of people in Houston live within a quarter of a mile to a bus stop.	**22% of population affected.** We have relatively good access to bus transit in Houston. This indicator is not sensitive to the frequency of bus trips. Good access, good frequency, and short trip times constitute a good transit system.
1. Population Growth	Population in Houston is currently growing at an average annual rate of approximately 1.42%.	**1.42% of population affected.** This is the equivalent of 30,000 persons per year, which Houston can easily absorb with regards to housing availability. Applying the 2.64 persons average household size for 2010, this yields 11,453 new households needed for 2011 and 122,131 housing units needed by 2020. There were 110,003 vacant housing units in the city of Houston according to the 2010 census (U.S. Census Bureau, 2011). This means that between 2011 and 2020 approximately 12,128 new housing units are needed.
13. Waste Generation	The total disposal tonnage for all counties in the Houston region dropped between 2000 and 2010. Additionally the disposal rate per person dropped from 9 to 7 lbs/person/day between those same years. It is not clear whether this was caused by reduction, recycling or reuse practices.	**100% of population affected.** Good progress has been made in the Houston region with reductions in waste disposal. The underlying problem is that public agencies depend on voluntary reporting mechanism from private haulers. Additionally private haulers do not have to report the type of waste they haul or the source of origin. This makes it difficult for public agencies to monitor source reductions.
22. Water Availability	The City of Houston owns access rights to a little less than half of the available water in the region. That was 1,264,231 acre-feet in 2010. The Houston municipal water demand for 2010 was 389,082 acre-feet.	**100% of population affected.** There are adequate water supplies for the City of Houston. The reporting mechanism often times confuses the needs of the city with the needs of its customers that are outside of City boundaries.

	The highest increase in land cover between 2001 and 2006 was for medium intensity development. This was an increase from 150 square miles to 160 square miles. Medium intensity development accounts for the highest land coverage type in Houston and most commonly include single family housing units.	**100% of population affected**. Within the City of Houston one issue is the protection of land as park and other open space.
24. Land Cover Change		

Houston Sustainable Development Indicators:

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by

Lester King, PhD, AICP, LEED

Glossary

Accessibility: The degree to which a product, device, service, or environment is available to as many people as possible.

Acre-feet: a unit of volume commonly used in the United States in reference to large-scale water resources. Equal to 325,851 gallons.

Affordable Care Act: A United States federal statute signed into law by President Barack Obama on March 23, 2010.

Agglomeration: An extended city or town area comprising the built-up area of a central place and any suburbs linked by continuous urban area.

Ambient concentration: Amount of the particulate or gas pollutant per volume unit of air.

Attainment gap: The observed and persistent disparity on a number of educational measures between the performance of groups of students, especially groups defined by gender, race/ethnicity, and socioeconomic status.

CO2 emissions: The release of carbon dioxide gas into the atmosphere.

Contiguous estuaries: Mixed fresh and salt water bodies that are connected or adjacent to each other.

Employment status: Refers to the three recognized work schedules of full-time, part-time and temporary.

Flood plain: A floodplain or flood plain is a flat or nearly flat land adjacent a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and

experiences flooding during periods of high discharge.

Food Desert: Any area more than 1 mile from a grocery store that sells fresh fruits and vegetables.

Fragile lands: Land that is sensitive to degradation when disturbed; such as with highly erodible soils, soils where salts can and do accumulate, and soils at high elevations.

GHG: A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range.

Globalization: Globalization is the process of international integration arising from the interchange of world views, products, ideas, and other aspects of culture.

GPCD: Unit for the water usage of an area, in gallons per capita per day.

Green jobs: Work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute(s) substantially to preserving or restoring environmental quality.

HGB: Acronym for the Houston-Galveston-Brazoria region.

Housing affordability: Relates to the ability of individual households to meet their monthly rent or mortgage payments within a reasonable threshold of their income.

kwh: Kilowatt-hour; a unit of energy commonly used for electricity purposes.

Land cover: Land cover is the physical material at the surface of the earth. Includes grass, asphalt, trees, bare ground, water, etc.

Medium intensity development: Includes areas with a mixture of constructed materials and vegetation.

Metropolitan Statistical Area (MSA): A geographical region with a relatively high population density at its core and close economic ties throughout the area.

Houston MSA: The Houston MSA is composed of 10 counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, Waller.

Municipal Solid Waste (MSW): A waste type consisting of everyday items that are discarded by the public.

Mwh: Megawatt-hour; one thousand kilowatt-hours; a unit of energy commonly used for electricity purposes.

National Ambient Air Quality Standards (NAAQS): Standards established by the United States Environmental Protection Agency under authority of the Clean Air Act that apply for outdoor air throughout the country.

Natural resources: Resources occurring naturally within environments that exist relatively undisturbed by mankind.

Personal Income: Refers to an individuals total earnings involving wages, investment enterprises, and other ventures.

PM 2.5, 10: Particulate matter of 2.5 or 10 micrometers; tiny pieces of solid or liquid matter associated with the Earth's atmosphere.

Poverty line: the minimum level of income deemed adequate in a given country.

ppb: Parts per billion; a unit of concentration of chemical compounds in the atmosphere.

ppm: Parts per million; a unit of concentration of chemical compounds in the atmosphere.

Primary jobs: A primary job is a job which brings in new capital (money) to an area.

Street intersection density: The number of street intersection per unit area in a metropolitan area.

Subsidence from groundwater extraction: The sinking of land resulting from groundwater extraction.

Vehicle Miles Traveled (VMT): A measure of the extent of motor vehicle operation within a specific geographic area over a given period of time.

Water availability: Describes the amount of water available for irrigation or consumption per person, per year in a region.

Wetland: Land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem.

µg: Microgram; unit of weight often used for small concentrations of contaminants.

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Appendix A – Experts and Advocacy Groups

Advisory Board – Rice University

John Anderson, PhD	**Jim Blackburn, JD**	**Stephen Klineberg, PhD**	**Lyn Ragsdale, PhD**	**Ron Soligo, PhD**
Geologist	Environmental Lawyer	Sociologist	Political Scientist	Economist
Research in Geosciences for 40 years	Environmental Law for 30 years	Houston Area Survey for 29 Years	Political Science for 30 Years	Energy Economics for 48 years

Experts and Advocacy Groups- City of Houston

Social Development Experts

Michael Emerson, PhD	Rice University
Peter Brown	Former City Council
Robert Bullard, PhD	Texas Southern University
David Crossley	Houston Tomorrow
Marlene Gafrick	City of Houston Planning Director
Rocaille Roberts, PhD	Healthy Living Matters
Diane Schenke	Greater East End Management District
Laura Solitare, PhD	Texas Southern University

Economic Development Experts

Theresa DeBose	Centerpoint Energy
Gavin Dillingham, PhD	Houston Advanced Research
George Granias	METRO, Chief Executive
Carol Lewis, PhD	Texas Southern University
Qisheng Pan, PhD	Texas Southern University
Laura Spanjian	Houston Sustainability Director
Fred Welch	Greater Houston Partnership, VP

Environmental Development Experts

Phil Bedient, Ph.D.	Rice University
Jun Chang	City of Houston Public Works Deputy Director
Thomas Colbert	University of Houston
Aston Hinds, Ph.D.	Port of Houston Environmental Director
Jim Lester, Ph.D.	Houston Advanced Research
Brandt Mannchen	Sierra Club
Martin Melosi, Ph.D.	University of Houston
Jeff Taebel	Houston Galveston Area Council
Matt Tejada, Ph.D.	Air Alliance Houston

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