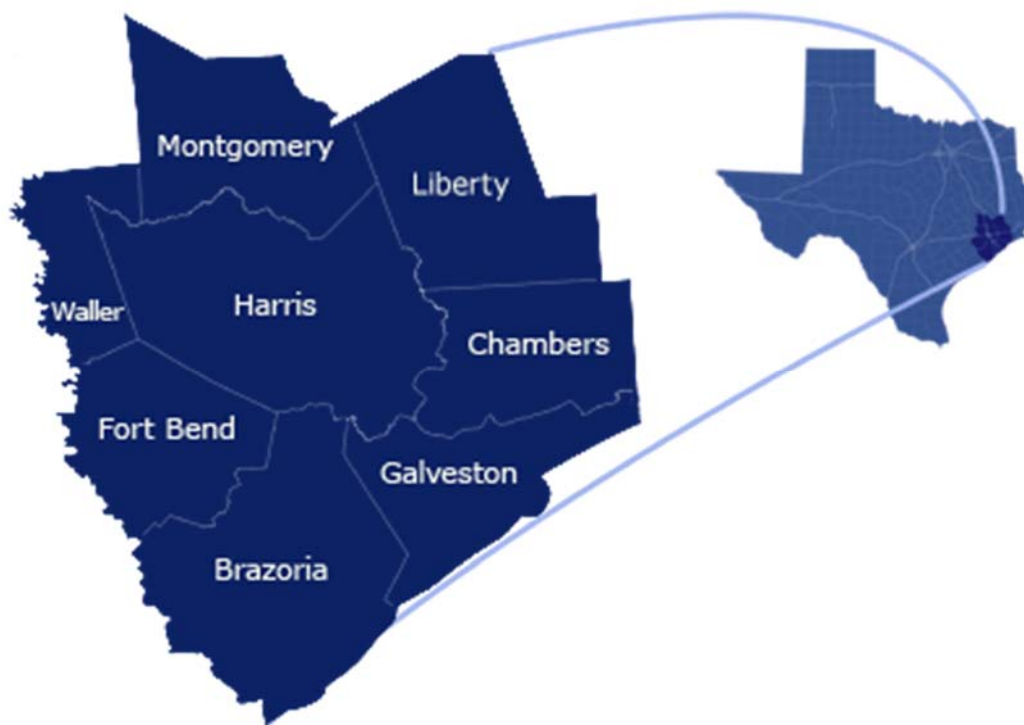

Houston-Galveston-Brazoria (HGB)

PM_{2.5} Advance

Path Forward Update



PREPARED IN PARTNERSHIP WITH MEMBERS OF THE
H-GAC REGIONAL AIR QUALITY PLANNING ADVISORY COMMITTEE

2021 UPDATE



HOUSTON-GALVESTON-BRAZORIA (HGB) PM_{2.5} ADVANCE PATH FORWARD 2021

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EXECUTIVE SUMMARY

H-GAC has developed the following Path Forward update in partnership with the Regional Air Quality Planning Advisory Committee (RAQPAC) and other regional stakeholders, as part of our involvement in the voluntary EPA Particulate Matter (PM) Advance Program. Participation in this program is a result of significant collaboration between local governments, key citizen/environmental groups, industry representatives, and other regional stakeholders to assist our region in continuing to meet the PM_{2.5} air quality standard.

On January 12, 2015, the EPA designated the Houston-Galveston-Brazoria (HGB) region as “unclassifiable/attainment” for the 2012 primary PM_{2.5} annual NAAQS. According to the federal reference methodology monitors within the HGB region, this area remains below the National Ambient Air Quality Standard for fine particle pollution.

Additionally, it is anticipated that by leveraging this existing regional collaboration on voluntary projects, our region hopes to better understand these existing issues and motivate efforts to continue to reduce PM_{2.5} concentrations and position the region to avoid a nonattainment designation under the current standard as well as remaining prepared for potentially more stringent future standards.

This Path Forward Update provides information about a variety of voluntary regional air quality improvement efforts. These projects range from the replacement of older heavy-duty truck and marine engines with newer, cleaner models, to funding electric vehicle charging equipment, to voluntary industry and local government air quality initiatives that serve to reduce emissions of fine particulates and other airborne pollutants. H-GAC’s programs as well as those sponsored and developed by regional stakeholders have resulted in PM_{2.5} reductions across our region and it is anticipated that these H-GAC and partner-sponsored programs and projects will continue to help the region achieve reductions in fine particulate matter.

INTRODUCTION

OVERALL PROGRAM OBJECTIVE

The Particulate Matter (PM) Advance Program is a voluntary, collaborative effort between governments and key regional stakeholders within PM_{2.5} attainment regions to organize and report on local efforts to continue to meet the National Ambient Air Quality Standard (NAAQS) health-based standards for PM as well as to foster an understanding of local air quality issues and promote the implementation of near-term initiatives to maintain and decrease PM concentrations within the Houston-Galveston-Brazoria (HGB) region. This region is currently in non-attainment for ground-level ozone but attains the standard for all other criteria pollutants including the current PM₁₀ and PM_{2.5} standards that became effective on December 14, 2012.

MISSION OF THE ADVANCE PROGRAM

The mission of the PM Advance Program is to promote, identify, expand, and improve voluntary PM reduction efforts (both existing and potential future opportunities) within the areas where compliance with the current PM_{2.5} NAAQS standard may be at risk. The HGB region is one of those at-risk areas. The Program also serves as a catalyst to encourage expanded and accelerated implementation of voluntary clean air strategies as well as to build interest and develop additional participation in PM reduction efforts in near-nonattainment areas. Participation in the PM Advance program also provides an opportunity for

stakeholders to promote their own PM reduction efforts and take advantage of funding opportunities that may be available to assist with additional reduction activities.

VOLUNTARY PROGRAM SCOPE

Participation in the PM Advance program has allowed the region to maintain an ongoing collaborative platform to help identify existing PM reduction efforts and encourage the development of new efforts. Regional stakeholders have worked together annually under the auspices of the Regional Air Quality Planning and Advisory Committee (RAQPAC) on a voluntary basis to help develop this Path Forward in order to help meet the program's stated mission. Program participation does not create or remove any statutory or regulatory requirements but can serve as an early action framework to maintain compliance with air quality standards. Additionally, due to the continued risk of future PM_{2.5} nonattainment for the Houston-Galveston-Brazoria Region, this document hopes to focus the conversation towards the development and implementation of sustainable PM_{2.5} reduction efforts within the region. Please note: this Path Forward update remains a living document. This is the eighth iteration of this report. It is anticipated that annual re-evaluation of existing and new local measures will continue with updates reflected in future versions of this report.

PROGRAM DEVELOPMENT PROCESS

The H-GAC Regional Air Quality Planning Advisory Committee (RAQPAC), representing local governments, citizen/environmental groups, and business/industry stakeholders, has examined potential voluntary actions that are anticipated to reduce levels of fine particulate matter in the form of PM_{2.5} within the HGB region. To this end, the H-GAC Board of Directors has authorized H-GAC staff to work with regional stakeholders to develop voluntary strategies to reduce fine particulate matter as recommended by RAQPAC and the PM_{2.5} Task Force.

The RAQPAC PM_{2.5} Task Force convened to collaborate on the development of the original PM Advance Path Forward. Task Force efforts included meetings to discuss and review of past, present, and potential future PM reduction projects within the eight-county HGB ozone nonattainment area amongst RAQPAC members, stakeholders, and the interested public. Efforts also included presentations on PM_{2.5} composition in Houston by TCEQ and others. This Task Force was reconvened in May of 2021 to assess the current state of fine particle pollution within the H-GAC region and begin work on this most recent update of this report. Following this meeting, H-GAC staff and Task Force members began the task of updating this document to include the most up-to-date information on regional PM_{2.5} reduction efforts.

THE REGION

HOUSTON-GALVESTON AREA COUNCIL

The Houston-Galveston Area Council (H-GAC) is the region-wide voluntary association of local governments for the 13-county Gulf Coast Planning region of Texas. H-GAC is also the Metropolitan Planning Organization (MPO) for the eight-county Houston-Galveston-Brazoria (HGB) area. This area includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller Counties. The scope of this report is focused on this eight-county region and is illustrated by the map to the right.

POPULATION & EMPLOYMENT¹

The HGB region has experienced dramatic changes in its population size and composition over the recent decades, and these trends are expected to continue. The region is projecting a significant increase in population and employment over the next 25 years. There are currently over 7 million residents and almost 3.1 million jobs within the HGB region. By 2045, the regional population is expected to reach 10.7 million residents (an increase of 4 million people). Similarly, the region is expected to create an additional 1.6 million jobs for a total of more than 4.8 million and see a more than 60% increase in vehicular travel and a doubling of the movement of freight. Projected population growth will also result in economic changes stemming from increased purchasing power and tax revenue.



TRANSPORTATION SYSTEM

Every day, more than 199 million miles are traveled on the system's roadways². Within our region, there are approximately 26,000 centerline miles of locally-owned roads and almost 4,000 centerline miles of state-owned facilities³. In addition, the region currently has more than 190 miles of High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) lanes in operation⁴. Regional transit includes bus routes, the METRORail light rail system, the METRORapid Silver Line, commuter transit routes, smaller vehicle routes, and ferries. The HGB region's transportation system also includes bikeways, freight rail, ports, airports, and pipelines.

Congestion remains a major challenge facing the HGB region. Regional congestion saw a significant decrease during 2020 as a result of the COVID-19 pandemic. As recovery has occurred through 2021, congestion has returned as the number of commuters travelling to and from work has increased once again. Moving forward, it is anticipated that congestion in our region will continue to grow given the projected population, employment, and economic growth facing our region.

¹ H-GAC, 2019: 2045 Regional Transportation Plan: [2045rtp.com](https://www.2045rtp.com)

² H-GAC [2019 Annual Mobility Report](#)

³ TxDOT Standard Reports 2012

⁴ H-GAC 2015 Regional Mobility Report

AIR QUALITY BACKGROUND: AIR POLLUTION

Air pollution occurs when the air contains gases, particles, fumes, or odors that could be harmful to the health or comfort of humans and animals or which could cause damage to plants and materials. These particulate pollutants may result from naturally occurring sources such as windblown dust, wildfires, or volcanic eruptions as well as stationary sources such as factories, power plants, or other industrial sites or mobile sources such as cars, trucks, construction equipment, or airplanes

The U.S. Environmental Protection Agency (EPA) has set both primary and secondary standards under the National Ambient Air Quality Standard (NAAQS) for six “criteria” pollutants. These pollutants include: carbon monoxide, lead, nitrogen dioxide, 10 micrometer particulate matter (PM₁₀), 2.5 micrometer particulate matter (PM_{2.5}), ground-level ozone, and sulfur dioxide. The region has historically been most troubled by high concentrations of ground-level ozone, however within the last decade there have been additional concerns about elevated concentrations of PM_{2.5}. It is the elevated concentrations of fine particulates and continued concern that instigated the regional participation in the PM Advance program.

Through this program, as well as through other EPA-led programs, H-GAC and its partners continue to work to reduce air pollution and help the region meet federal air quality standards. These efforts have helped the region make considerable progress towards reducing both ground-level ozone and particulate matter emissions over the last decade.

PARTICULATE MATTER (PM)

Particle pollution is a complex mixture of extremely small particles originating from natural or man-made sources. This type of pollution is generally referred to as particulate matter or PM. Components of PM include particles of solids or liquids that can include: dust, fly ash, soot, smoke, aerosols, fumes, and mists as well as condensed vapors that have been suspended in the air. EPA groups particle pollution into two categories: inhalable coarse particles (PM₁₀) and fine particles (PM_{2.5}). The size of these particles is directly linked to their potential for causing health problems. Particles smaller than 10 micrometers in diameter (PM₁₀ and PM_{2.5}) are able to pass through the respiratory system and deep into the lungs where they can cause serious health effects. Fine particulate matter (PM_{2.5}) generally consists of soot, which is generally made up of elemental organic carbon from sources including soil and sources of sulfates, nitrates as well as other ionic species formed in the atmosphere.

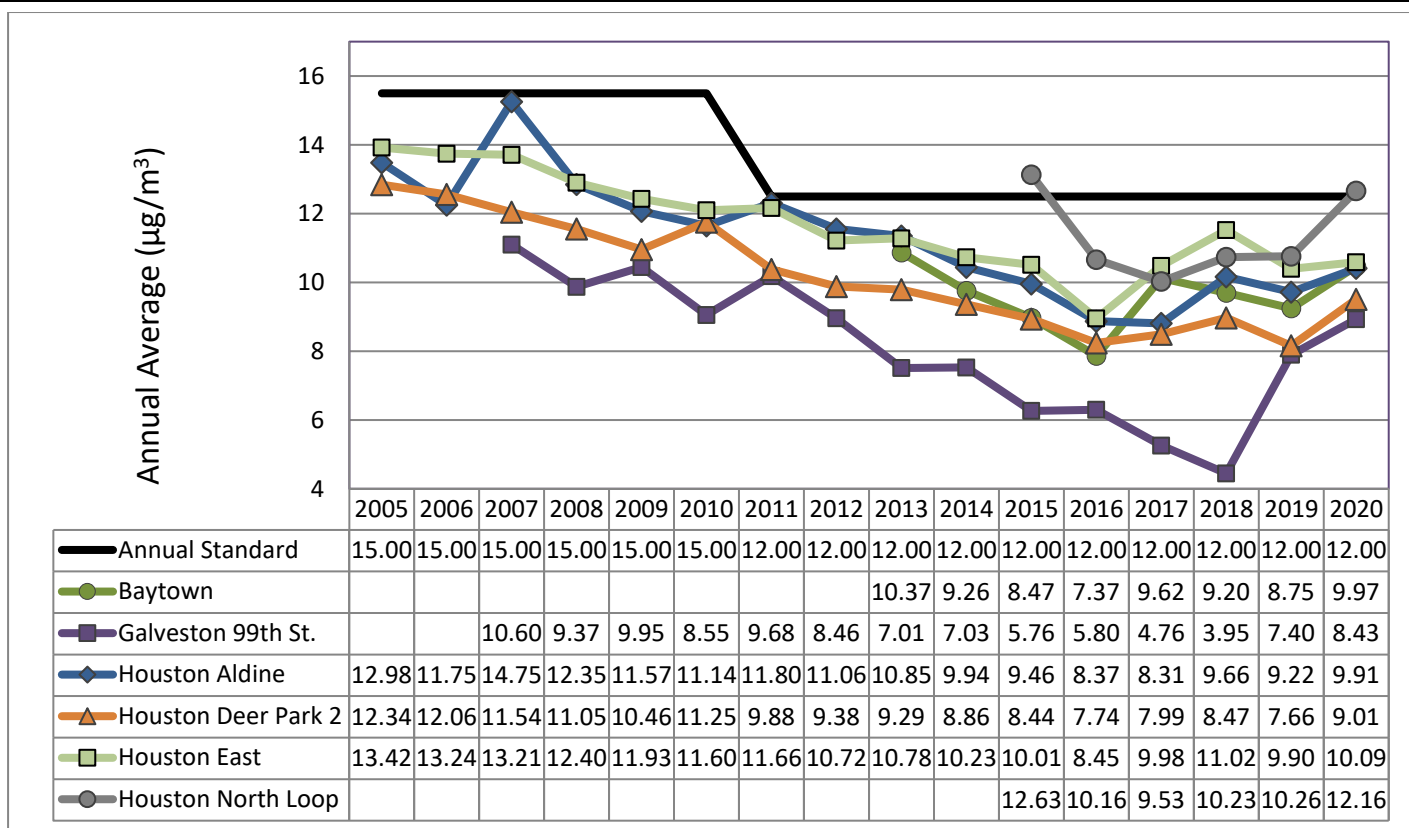
PAST AND PRESENT STATUS OF PM_{2.5} IN HGB

The HGB area has experienced significant improvements in PM_{2.5} levels over the past decade. Historically, the region has been designated as “unclassified/attainment” for both the PM_{2.5} and PM₁₀ particulate matter standards. Details of the particulate matter NAAQS standards can be found in the table below. Note that in 2012, EPA lowered the primary annual NAAQS for fine particles (PM_{2.5}) to 12.0 µg/m³ to be more protective of public health.

Pollutant	Primary NAAQS	Averaging Period	Designation
Particulate Matter (PM ₁₀)	150 µg/m ³	24-hour	Attainment/ Unclassifiable
Particulate Matter (PM _{2.5})	12.0 µg/m ³ (2012 standard)	Annual (Arithmetic Mean)	Attainment/ Unclassifiable
	15.0 µg/m ³ (1997 standard)	Annual (Arithmetic Mean)	Attainment/ Unclassifiable
	35 µg/m ³	24-hour	Attainment/ Unclassifiable

Air monitoring data collected, compiled, and validated by the Texas Commission of Environmental Quality (TCEQ) identifies the certified PM_{2.5} annual design value⁵ for 2010-2012 for the HGB region as 12.1 micrograms per cubic meter (µg/m³). Over the subsequent years, TCEQ closely monitored PM_{2.5} concentrations and found a continuing decline in annual PM_{2.5} averages in the HGB area (see table below). On January 15, 2015, the EPA published designations for the 2012 primary annual PM_{2.5} NAAQS. The HGB region was classified as “unclassifiable/attainment.”

Preliminary Annual PM_{2.5} Averages for HGB Region Regulatory Monitors⁶



⁵ A “design value” for an area is a statistic that is compared to the National Ambient Air Quality Standards (NAAQS) to determine the attainment status of the area. An area value is calculated using an arithmetic mean of the annual PM_{2.5} averages for three consecutive years at each regulatory monitor. If an area has more than one regulatory monitor, the monitor with the highest value sets the design value for the area (EPA, 2014).

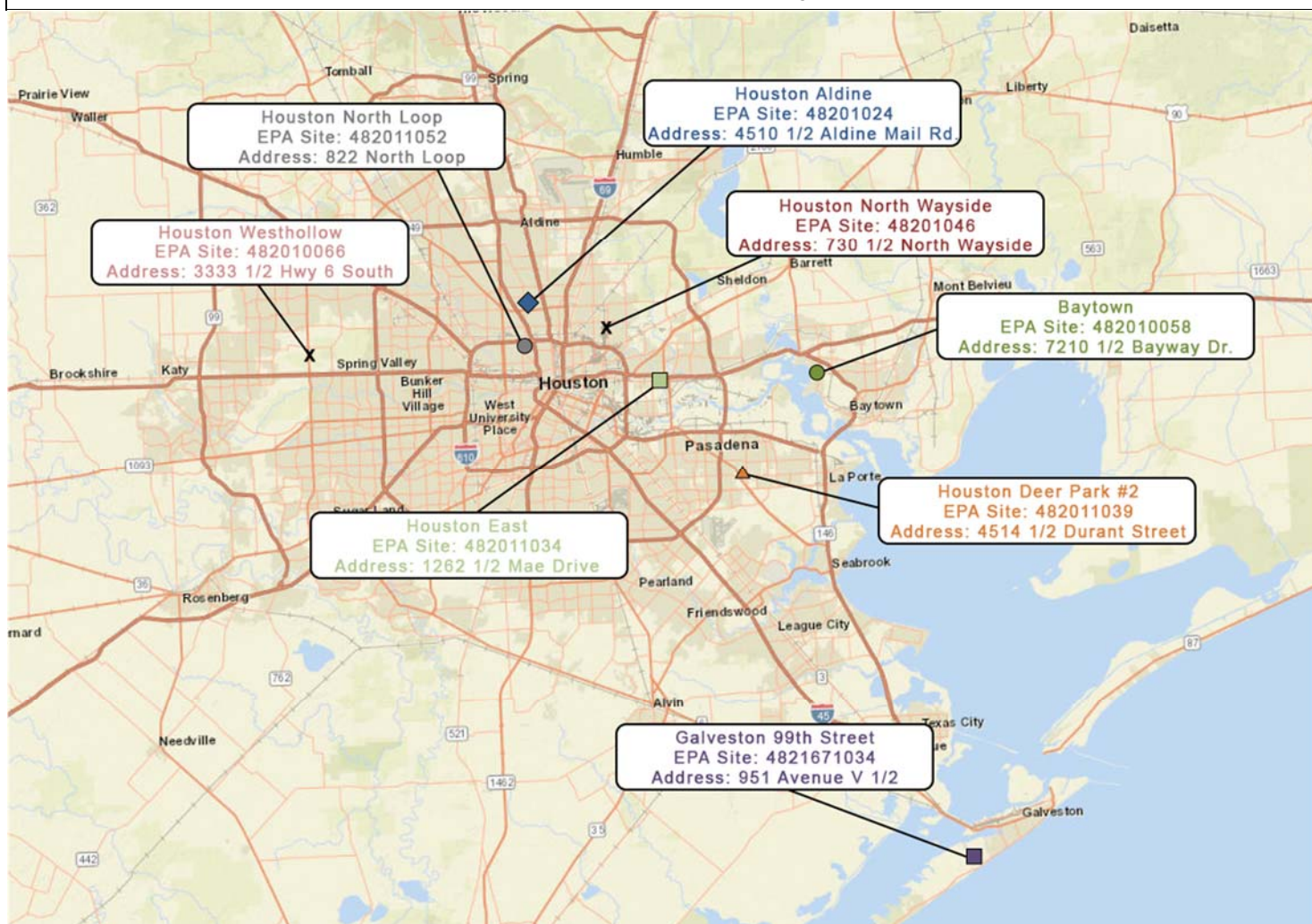
⁶ All values within this chart are certified. Only the data from these regulatory monitors will be used by EPA for attainment demonstration purposes. Source:: TCEQ Source: TCEQ Source: TCEQ TAMIS Database - <http://www17.tceq.texas.gov/tamis/>

EPA most recently promulgated final area designations for the 2012 PM_{2.5} NAAQS on December 18, 2014. Air monitoring data for each of these monitoring locations can be retrieved from the TCEQ Texas Air Monitoring Information System (TAMIS) web: www17.tceq.texas.gov/tamis/.

HGB MONITORING NETWORK

Over time, the monitoring system in the HGB region has expanded significantly. Presently there are eight active monitoring sites with regulatory PM_{2.5} monitors located within the HGB region. The City of Houston, Harris County, University of Houston, Texas Commission on Environmental Quality (TCEQ), and Houston Regional Monitoring Corporation (HRM) as well as others operate these monitors as part of the regional network. Most of these monitoring stations not only measure the concentrations of the criteria pollutants in the air, but also other meteorological parameters such as air temperature and wind velocity, among others. Some of the monitoring stations also measure the levels of an additional set of selected pollutants that includes air toxics, pollen, and mold spores. Two of these monitors, Houston North Wayside and Houston Westhollow became operational in 2021. As a result, no verified data is available for either station at the time of this report being developed. As a result, neither of these stations appear in the annual PM_{2.5} average chart above. They do, however, appear on the map of existing regulatory monitoring sites as found below. Beyond these existing eight stations, TCEQ is considering installation of several additional PM_{2.5} monitors to be placed within vulnerable communities in the region.

EXISTING HOUSTON-GALVESTON-BRAZORIA REGION PM_{2.5} REGULATORY MONITORING SITES



The following table of monitoring sites lists the eight HGB PM_{2.5} monitor sites that are currently operating within the HGB region and are also classified as Federal Reference Method (FRM) monitor sites by the EPA. PM_{2.5} data from the Baytown, Galveston 99th St., Houston Aldine, Houston Deer Park #2, Houston East, Houston North Loop, Houston North Wayside, and Houston Westhollow monitors are currently used to determine HGB attainment with the PM_{2.5} NAAQS.

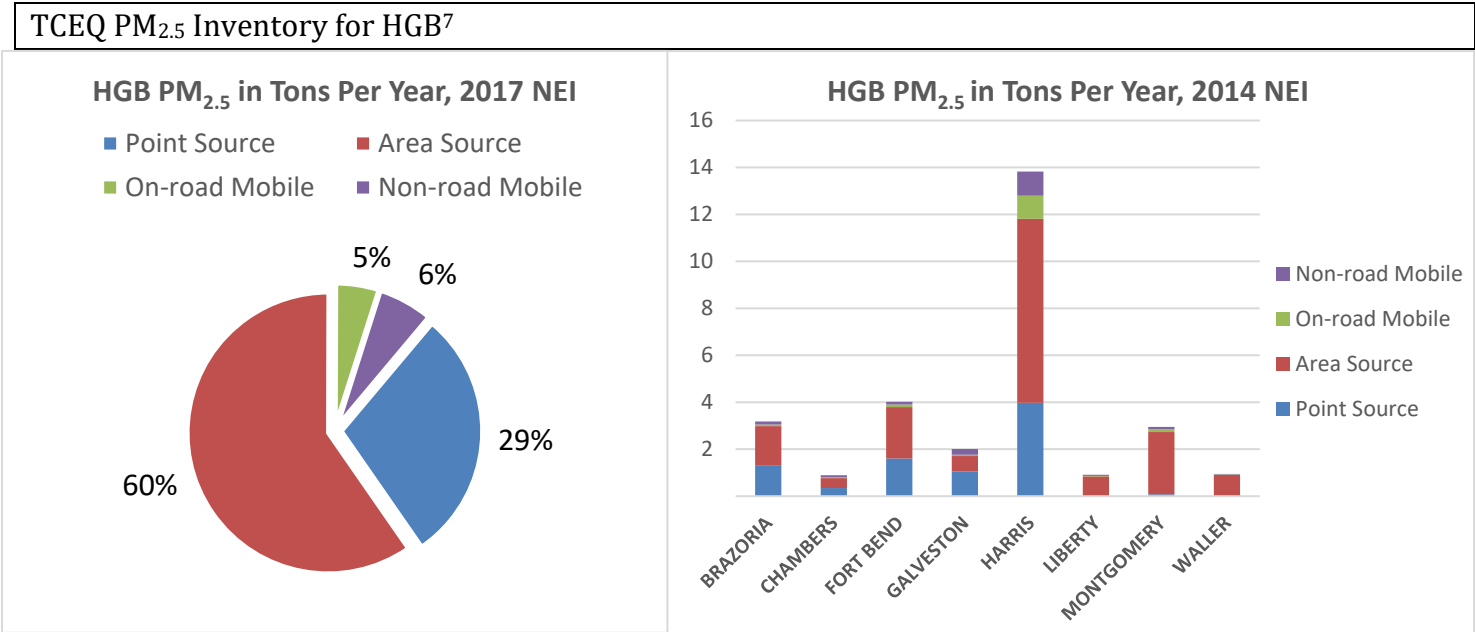
These federal reference monitors (FRM) utilize the appropriate sampling and analysis methods as well as quality assurance/quality control (QA/QC) protocols for use in determining attainment demonstration status with the fine particulate matter standard. Monitoring sites with FRM monitors are considered regulatory monitors. There are numerous additional PM_{2.5} monitors within our region that are not considered regulatory monitors, but data from these other monitoring sites is used by TCEQ to help understand air quality data and trends and predict possible alerts.

HGB Region PM _{2.5} Regulatory Monitoring Sites						
Region	Name	CAMS ID	Address	AQS Number	Sampler Type	First Valid Data
12	Baytown	C0148	7210½ Bayway Dr, Baytown	482010058	PM _{2.5} (FRM)	3/15/2017
12	Galveston 99 th Street	C1034	9511 Avenue V½, Galveston Airport, Galveston	481671034	PM _{2.5} (FRM)	4/15/2019
12	Houston Aldine	C0008	4510½ Aldine Mail Rd, Houston	482010024	PM _{2.5} (FRM)	4/22/2019
12	Houston Deer Park2	C0035	4514½ Durant St, Deer Park	482011039	PM _{2.5} (FRM)	12/14/2010
12	Houston East	C0001	1262 ½ Mae Drive, Houston	482011034	PM _{2.5} (FRM)	7/12/2017
12	Houston North Loop	C1052	822 North Loop, Houston	482011052	PM _{2.5} (FRM)	5/12/2021
12	Houston North Wayside	C1033	7330 ½ North Wayside	482010046	PM _{2.5} (FRM)	5/4/2021
12	Houston Westhollow	C3003	3333 ½ Hwy 6 South	482010066	PM _{2.5} (FRM)	1/14/2021

To view the data from all continuous TCEQ monitors, please follow this link: www.tceq.texas.gov/airquality/monops/sites/mon_sites.html. Please be aware that the PM_{2.5} monitor at the Houston North Loop site is a non-continuous monitor. Data from this monitor is made available by TCEQ on a quarterly basis after results have been manually collected and analyzed in the laboratory.

HGB PM_{2.5} INVENTORY

The following PM_{2.5} inventory is based on TCEQ’s adjusted 2017 National Emissions Inventory (NEI) data. The NEI is a comprehensive, detailed estimate of criteria and hazardous air emissions sources. The NEI is prepared every three years by the EPA based primarily upon emission estimates and emission model inputs provided by State, Local, and Tribal air agencies for sources in their jurisdictions, and supplemented by data developed by EPA. The 2017 NEI was built from emissions data in the Emissions Inventory System (EIS). The 2017 version of the NEI is the most current edition available. Publication of the upcoming 2020 inventory is expected in 2023.



These data are split into four emission categories: point, on-road mobile, non-road mobile and area (non-point) sources. Point sources are individually inventoried and usually located at a fixed, stationary location (heaters, boiler and cooling water towers at large industrial facilities), although portable sources are also included (some rock crushing operations). On-road mobile sources include emissions from vehicles found on roads and highways (cars, trucks, and buses); while non-road mobile sources include mobile sources not found on roads and highways (lawn mowers, construction vehicles, farm machinery, rail, airplanes, and commercial marine vessels). Area (non-point) sources include those sources that are inventoried collectively because they are too small in magnitude or too numerous to inventory as individual point sources, and which can often be estimated more accurately as a single aggregate source (residential heating, leaf blowers, and unpaved roads). The estimated emission values for TCEQ non-point sources in the chart below are taken from the Texas Air Emissions Repository (TexAER).

⁷ TCEQ’s adjusted 2014 NEI data follows the same quality assurance and quality control process as data in the Reasonable Further Progress (RFP) and Attainment Demonstration (AD) State Implementation Plan (SIP).

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TCEQ PM _{2.5} Inventory for HGB (tons per year) ⁸				
	Point Source	On-Road Mobile	Non-Road Mobile	Area Source
Brazoria	1,322	1,661	69	126
Chambers	347	422	32	88
Fort Bend	1,608	2,184	108	119
Galveston	1,052	656	55	249
Harris	3,978	7,840	977	1,032
Liberty	4	839	20	48
Montgomery	84	2,649	116	97
Waller	5	898	22	22
Total	8,401	17,148	1,399	1,782

HARRIS COUNTY PM_{2.5} INVENTORY SUMMARY

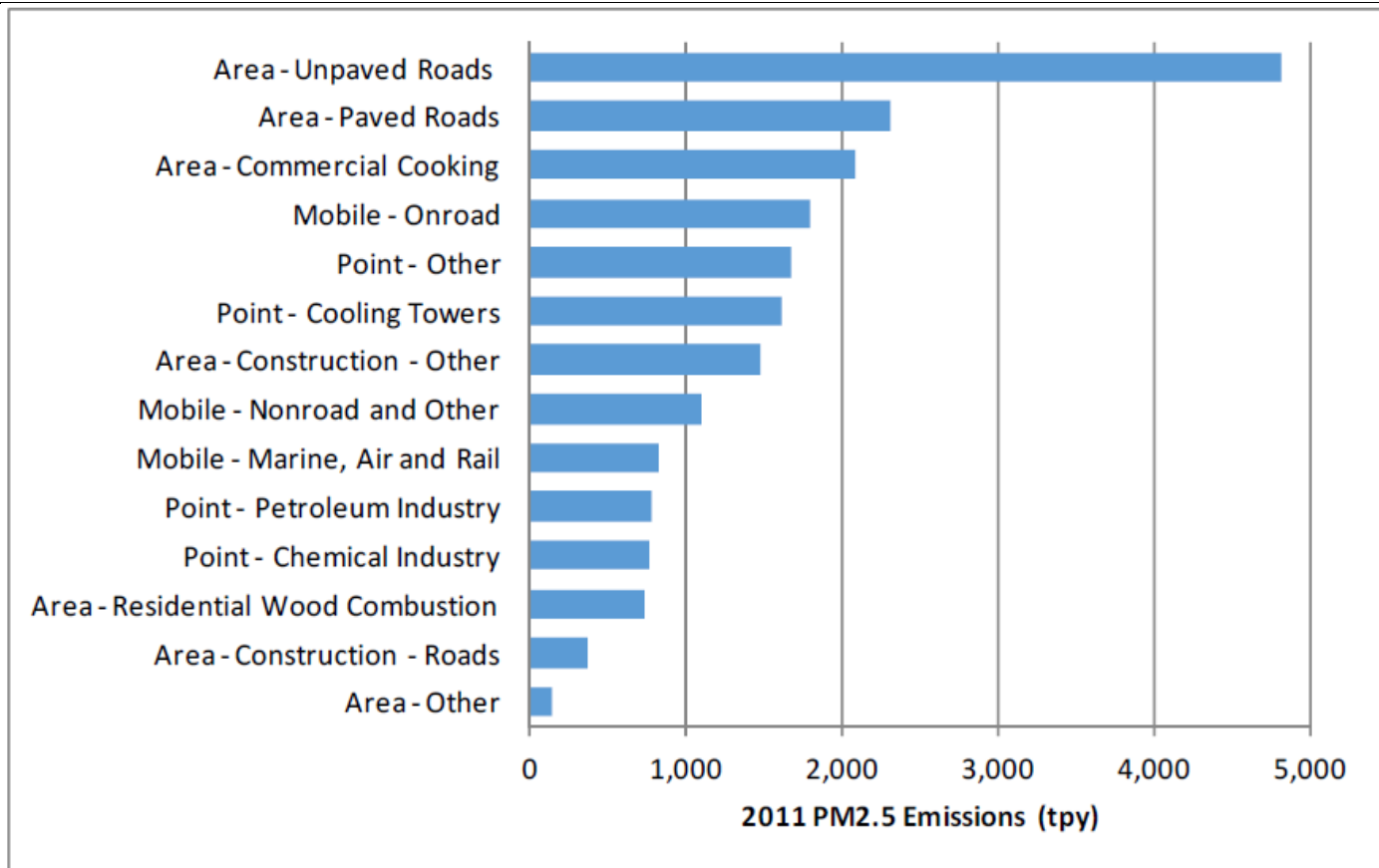
Houston Advanced Research Center (HARC), in partnership with Harris County, spearheaded an effort to further investigate sources of PM_{2.5} within Harris County: the Harris County PM_{2.5} Emissions Inventory project. At the time of the creation of this inventory, ambient air quality monitoring data indicated that the Houston area (and in particular the Clinton Drive PM_{2.5} monitor) measured at near the level of the annual average PM_{2.5} NAAQS.

This project was funded by a Coastal Improvement Assistance Program (CIAP) grant, administered by the U.S. Fish and Wildlife Service through Harris County. The aim of this portion of the grant was to review the PM_{2.5} inventories developed by TCEQ and EPA for Harris County, make adjustments when technically justified, and provide a list of potential controls, including their efficiencies and costs that might be used to reduce PM_{2.5} emissions based on the revised inventory.

This inventory summary is broken down into three categories of emissions: point, mobile and area sources using NEI inventory definitions. This inventory summary identifies unpaved roads as the predominant source of PM_{2.5} within Harris County.

⁸ TCEQ Data Sources: 2011 rail and locomotive – 2011, 2011 area source v2, 2011 commercial marine vessels, 2011 AERR on road annual criteria, 2011 non-road annual criteria pollutants, 2011 At 2011 Drilling Rigs Controlled, 2011 aviation - if non-road. Point Source PM estimates obtained from TCEQ for 2013. The data is subject to revisions or updates. All data is subject to revisions or updates.

2011 Harris County Annual PM_{2.5} Emissions



Since the creation of this inventory, PM_{2.5} monitors within the Houston region have shown significant reductions of approximately 25% or more. It is anticipated that future versions of this inventory will show a similar magnitude of reduction.

ELEVATED PM_{2.5} IN WESTERN HOUSTON

According to a recently published study conducted by Harvard University and funded by US EPA, a large plume of PM_{2.5} pollution, exceeding the 12 µg/m³ NAAQS standard has been forming in western Houston. This feature had never previously been identified due to a lack of air quality monitors in that portion of the region. This new study used a combination of satellite imagery and other data to identify the elevated PM_{2.5} concentrations. Based, in part, on this new study, TCEQ has stated in their 2020 Annual Monitoring Plan⁹ that they plan to install a new FRM PM_{2.5} monitor in western Houston by December 2020.

In addition to posing a serious health risk to residents, the Harvard study suggests the need for additional research to conduct a speciation/source apportionment study to understand what is causing these increased concentrations, and to develop an action plan to reduce the sources of emissions.

⁹ https://www.tceq.texas.gov/assets/public/compliance/monops/air/annual_review/historical/2020-AMNP-Portfolio.pdf

The Harvard study¹⁰ estimated daily PM_{2.5} concentrations nationwide at a resolution of 1 km x 1 km for 2000 to 2015. The study utilized 3 machine learning algorithms: 1) neural network, 2) random forest and 3) gradient boosting and more than 100 predictor variables including a unique combination of FRM PM_{2.5} monitoring, EPA CMAQ, land-use, satellite, meteorological, and other data. Cross-validation methods were employed to control for overfitting and spatial and temporal autocorrelation were incorporated in modelling to improve performance. A geographically weighted regression model was used to combine results of these three machine learning approaches to obtain high resolution PM_{2.5} estimates for the entire US. The model performed well up to 60 µg/m³ with an R² of 0.86 for the daily PM_{2.5} predictions and 0.89 for the annual results.

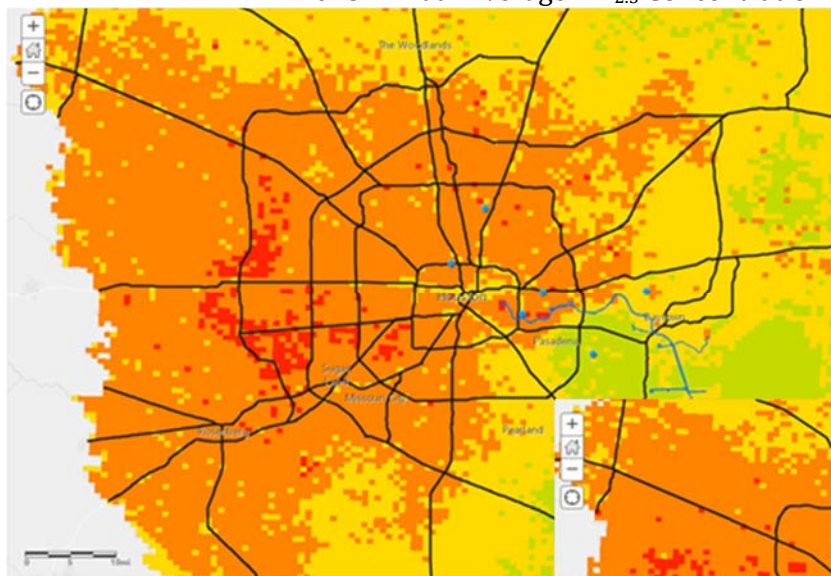
Using the ensemble data from the Harvard study, the Environmental Defense Fund (EDF) evaluated annual PM_{2.5} concentrations for the eight county Harris, Brazoria and Galveston region. As can be seen in the maps below, the data shows a steady increase in PM_{2.5} concentrations in western Houston from 2013 to 2015 (the most recently available data). The ensemble analysis, including the satellite data, made it possible, for the first time, to identify this air pollution even though there were no FRM monitors located in western Houston.

EDF also evaluated the correlation between predicted ensemble data and measurements from six FRM monitors located in the Houston area. Comparison of daily ensemble and FRM data for 2015 showed a Spearman's rho of 0.87 to 0.93. On a quarterly basis, the correlation coefficient ranged from 0.80 to 0.95. For the summer months, when PM_{2.5} levels were highest, the correlation between ensemble and FRM data ranged from 0.91 to 0.95. Overall, these results indicate ensemble estimates were highly correlated with measurements from Houston area FRM PM_{2.5} monitors.

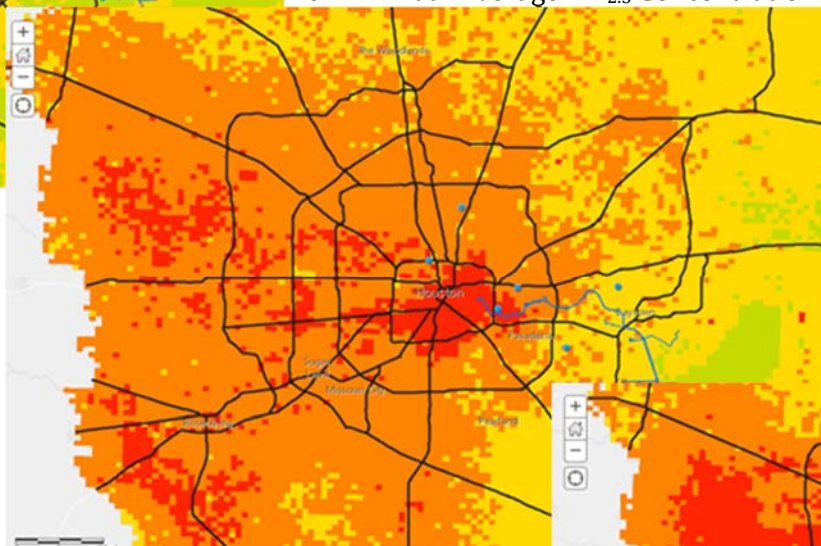
The maps on the next page show, the annual average PM_{2.5} concentrations in the Houston area for 2013, 2014 and 2015. As can be seen, the red areas of the map, where annual average PM_{2.5} exceeds 12 µg/m³ increase each year by a substantial amount. The blue dots on the maps are the location of existing FRM PM_{2.5} monitors. There is currently no FRM PM_{2.5} monitor in west Houston.

¹⁰ Qian Di, et al. *An ensemble-based model of PM_{2.5} concentration across the contiguous U.S. with high spatiotemporal resolution*. Environment International 130 (2019) 104909.

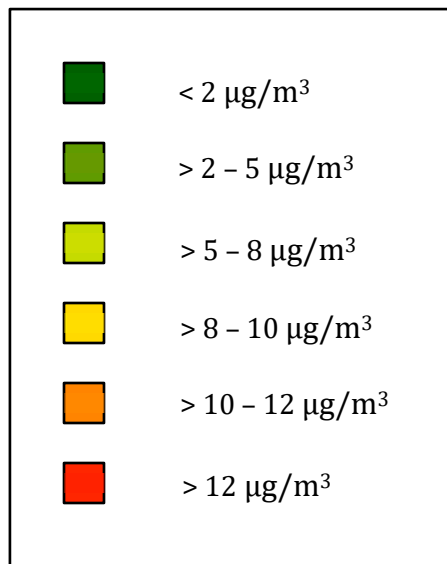
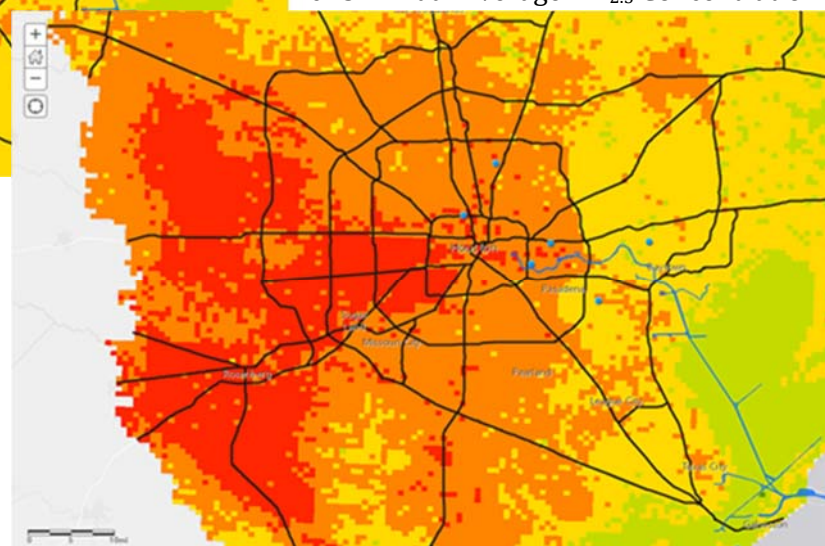
2013 Annual Average PM_{2.5} Concentration



2014 Annual Average PM_{2.5} Concentration



2015 Annual Average PM_{2.5} Concentration



HEALTH DAMAGES FROM PARTICULATE MATTER POLLUTION

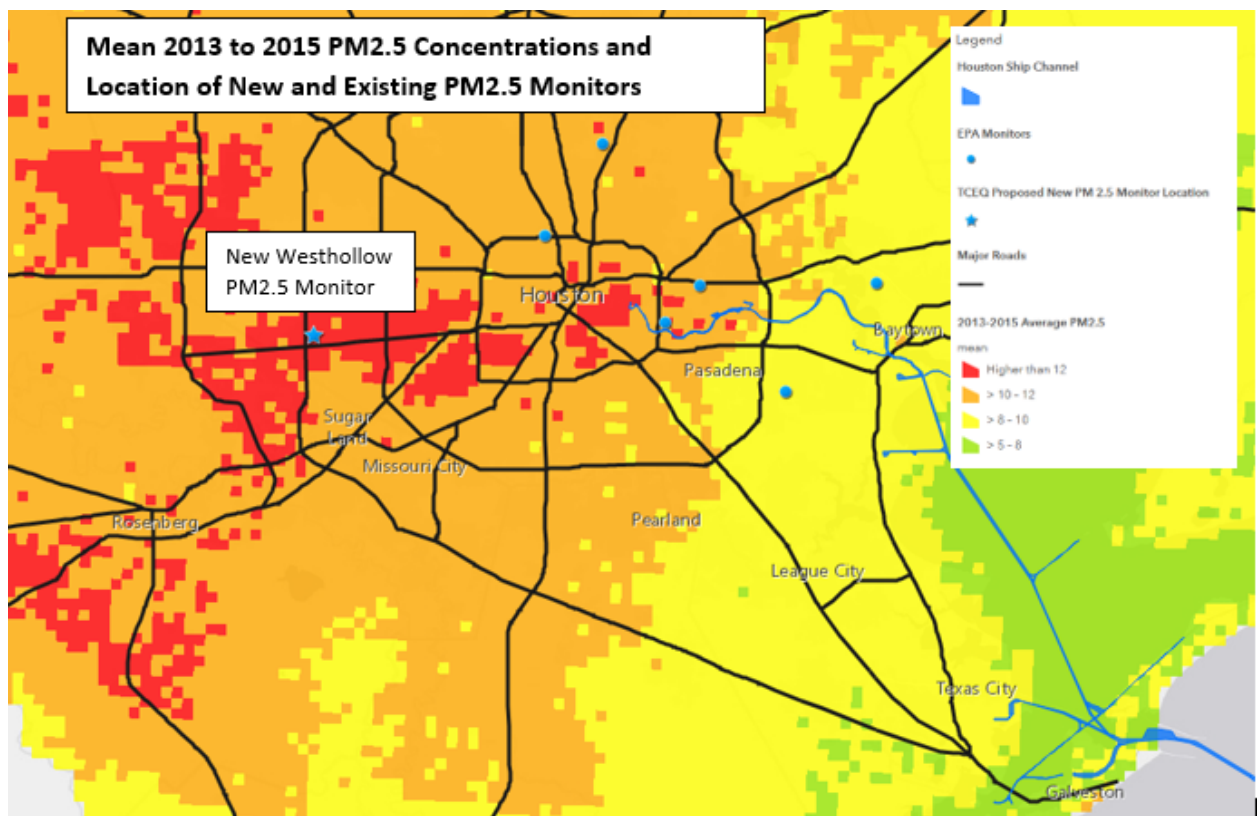
Elevated levels of PM_{2.5} have major health and economic consequences for residents of Houston. A new analysis¹¹ from the Harvard School of Public Health and EDF has found that the 2015 elevated levels of PM_{2.5} in Houston were responsible for over 5,200 premature deaths, and more than \$49 billion in economic damages.

Particulate pollution is made up of small toxic airborne particles like dust, soot, and liquid particles, or aerosols. Most particulate pollution in Houston is from the chemical and petroleum industry, power generation, and diesel vehicles and construction equipment.

These toxic particles penetrate deep into the lungs and are linked to heart attacks, lung disease, strokes, asthma, cancer, and can lead to early death. This pollution is particularly dangerous for young people – studies show that PM_{2.5} exposure can impair childhood lung development.

NEW TCEQ PM_{2.5} MONITOR

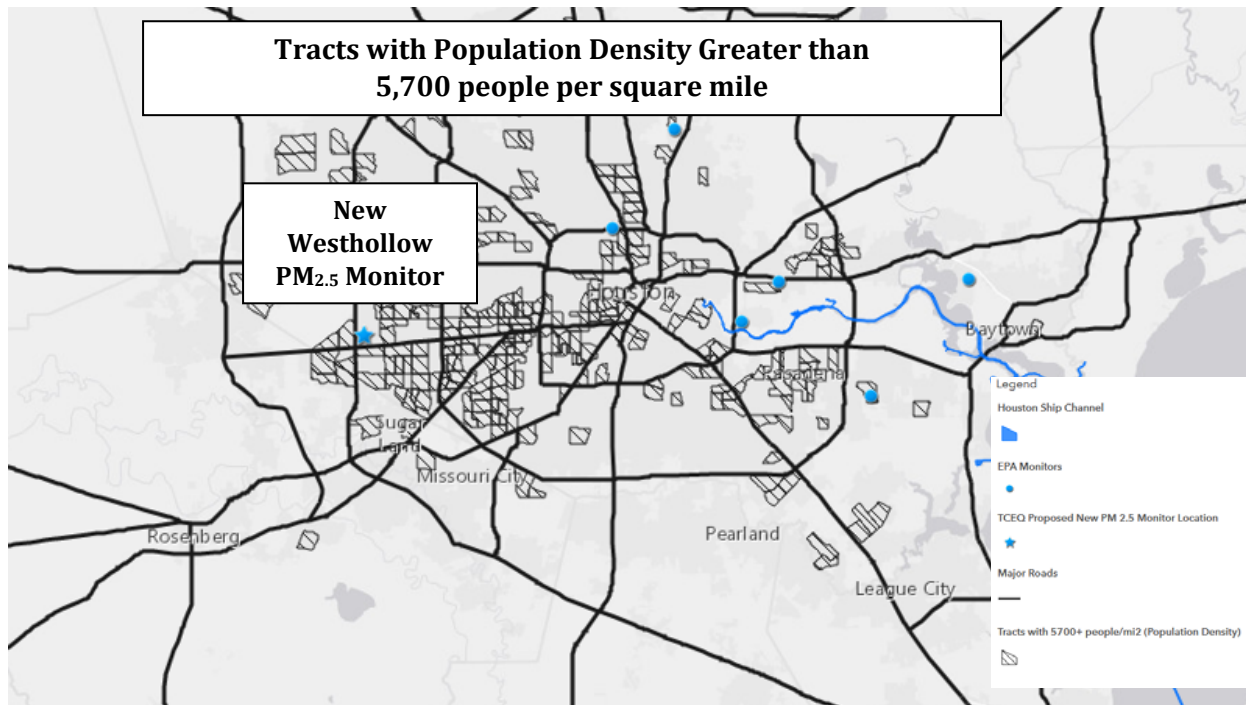
In response to this new data, TCEQ installed a new PM_{2.5} monitor at the City of Houston's existing Westhollow monitoring station. In selecting this site, TCEQ followed EPA requirements¹² to locate the monitor in "an area of expected maximum concentration" and in areas of higher population density where people live, work and, play. The figure below shows the location of the new PM_{2.5} monitor and the mean 2013 to 2015 PM_{2.5} concentrations.



¹¹ <http://blogs.edf.org/health/2020/05/11/pm-standards-houston-analysis/>

¹² Title 40, Chapter I, Subchapter C, Part 59, Appendix D, Section 4.7.1(b)(1)

The second criteria for determining the location of FRM PM_{2.5} monitors is population density. The map below shows the areas where population density is greater than 5,700 people per square mile.¹³ While the Westhollow site is not located in a tract where the population density exceeds 5,700 people per square mile, it is located adjacent to these higher density tracts.



NEXT STEPS

As discussed, ensemble modeling suggests that PM_{2.5} concentrations in West Houston may be above the National Ambient Air Quality Standards. While the performance of this modeling has been evaluated using reference grade monitor data from eastern Houston, because no monitor data was available over West Houston, there is a need to further explore these pollution patterns and confirm accuracy of the ensemble data by conducting “ground-truthing” measurements (reference grade measurements in the area being modeled). To do this, EDF has reached out to academic researchers in Texas with expertise in atmospheric measurement campaigns, to propose a monitoring study that will not only specifically target PM_{2.5} in West Houston to confirm ensemble model findings, but the study has been designed to also provide information about sources through PM_{2.5} speciation data.

Because PM_{2.5} is made up of several different types (species) of air pollutants with different types of air pollution sources contributing to each species, by breaking up total PM_{2.5} measurements into the species components, and using wind data to look at flow patterns, the proposed measurement study could not only confirm or disprove the ensemble model, it could start to help the region understand what types of sources are contributing the most to PM_{2.5} in Houston. This is key to developing effective control strategies to reduce air pollution for Houston’s residents and moving forward the efforts associated with the Advance Program.

¹³ We chose 5,700 people/mi² based on “natural breaks” in the distribution of the data from ArcGIS.

SOURCE APPORTIONMENT

Source Apportionment (SA) studies quantify the contribution of individual sources to particulate mass loadings based on source profiles and receptor characteristics with the nature of pollutants. There are large variations in the physio-chemical characteristics of PM, which are based differences in intensities of the sources in different regions. Based on outcomes of 149 SA studies conducted in 51 countries, 25% of PM_{2.5} mass is contributed by traffic, 15% by industrial activities, 20% by domestic fuel burning, 18% from natural dust and salt, with the rest from unspecified anthropogenic sources¹⁴. Source categories also have diverse characteristics in terms of their chemical composition. Considering the large variations in source contributions due to spatio-temporal heterogeneity, a comprehensive spatio-temporal source apportionment study protocol is required including detailed physio-chemical analysis of the PM as a function of their size in all air quality management programs. Source profiles are the characteristics of emission sources with each chemical species articulated as a mass fraction of the total mass emitted. There have also been only limited source apportionment studies with a focus on PM_{2.5} and its associated effect on health, visibility and climate change.

The use of low-cost sensors may help in the identification and selection of the SA monitoring sites by studying the spatial variations in the area and finding representative sites – residential, industrial, commercial, etc. There is a need to validate the receptor model results with dispersion models to assess whether they align in terms of source estimations. This comparative analysis can help quantify the emissions from the unidentified sources. There is a need to create region-specific source profiles as the source characteristics vary significantly depending on the origin of sources particularly soil/road dust, vehicular emissions due to different fuel qualities, utilized coal characteristics (sulfur content based on region from where it has been mined), combustion sources, etc. It is also necessary to include the secondary pollutants formed in the atmosphere by the reaction of primary pollutants after they are emitted.

METALS

Toxic metals such as arsenic (As), cadmium (Cd), nickel (Ni), and lead (Pb) exist in the atmosphere as particulate matter components. Metals in the urban atmosphere are mainly derived from industrial activities (mining, smelting, and fossil fuel combustion), traffic emissions (vehicle exhaust and the products of wear from tires, brake linings, and bearings), and natural sources (minerals, forest fires, and oceans). Atmospheric metal concentrations are dependent on the natural background concentrations, level of economic development and the overall planning features of an urban area. The area's energy production and use patterns are likely closely linked to atmospheric metal pollution, especially in the Houston region which derives most of its energy from fossil fuels.

In order to control atmospheric metal pollution, it is essential to undertake effective environmental risk management. Rapid evaluation models on spatiotemporal distributions of metals and practical early warning programs could be developed by combining the monitoring data with interdisciplinary research, such as atmospheric pollutant diffusion models, epidemiological investigations, toxicological

¹⁴ Karagulian, F., Belis, C. A., Dora, C. F. C., Prüss-Ustün, A. M., Bonjour, S., Adair-Rohani, H., & Amann, M. (2015). Contributions to cities' ambient particulate matter (PM): A systematic review of local source contributions at global level. *Atmospheric environment*, 120, 475-483.

experiments, and geographical information systems. There are still potentially important problems that require special attention and further study before we will have a comprehensive understanding of the occurrence and behavior of metals in PM.

Modelling tools are recommended to support air quality assessment regarding the toxic metals; however, few studies have been performed and those assessments rely on discrete measurements or field campaigns. Here in Houston, we need to evaluate the capability of metals monitoring and air quality modelling tools to verify the legislation compliance concerning the atmospheric levels of toxic elements and to identify the main challenges and limitations of using a modelling assessment approach for regulatory purposes, as a complement to monitoring.

PAST AND PRESENT INITIATIVES

AIR QUALITY PROGRAMS AT H-GAC

H-GAC has partnered with local and regional government agencies, citizen and environmental groups, business and industry-based organizations and other stakeholders to proactively pursue air quality improvements within our region. Currently, more than 12 major emission reduction programs are underway at H-GAC to help improve to the region's ozone non-attainment status. These programs have multi-pollutant benefits and, despite their focus on reducing ground-level ozone, have resulted in significant PM_{2.5} reductions in the past.

CLEAN VEHICLES & CLEAN SCHOOL BUS PROGRAMS

Since 1995, the Clean Vehicles Program has provided grant assistance to replace older diesel engines in both public and private fleets within the HGB region. This fuel neutral program is designed to reduce on-road vehicle emissions by rapid turnover to newer lower emitting engines, retrofit of existing engines with approved devices, or introduce new lower emission technologies. Both of these programs are ongoing and have resulted in the replacement of hundreds of older vehicles with new, cleaner replacements.

The Clean School Bus program serves the following counties: Angelina, Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Hardin, Harris, Houston, Jasper, Jefferson, Liberty, Matagorda, Montgomery, Nacogdoches, Newton, Orange, Polk, Sabine, San Augustine, San Jacinto, Trinity, Tyler, Walker, Waller, and Wharton. The goal of the program is to reduce children's exposure to diesel exhaust and reduce the amount of air pollution created by diesel school buses.

DRAYAGE LOAN PROGRAM

Since 2010, the H-GAC Drayage Loan Program has offered independent owner operator and/or trucking companies servicing HGB ports the opportunity to apply for financing to support the purchase of cleaner, safer and more fuel-efficient drayage trucks. Almost 900 tons of NO_x reductions and 14 tons of PM emission reductions are anticipated over the life of the program. This program has been a collaborative effort between H-GAC, Environmental Defense Fund, and Port Houston.

CLEAN VESSELS FOR TEXAS WATERS

In 2011, EPA awarded H-GAC almost \$1 million to repower 3 high-emitting tug vessels with 8 new, cleaner engines. The repowered vessels mainly operate in the HGB non-attainment area—docking ships and

fueling marine vessels. The project has already completed the replacement of 8 engines and reduces approximately half a ton of PM_{2.5} emissions annually.

COMMUTE SOLUTIONS: TELEWORK

The Telework Program helps regional employers and employees by educating them about the benefits of teleworking and offering financial incentives to develop and implement telework as well as alternative work schedule programs.

COMMUTE SOLUTIONS: PILOT PROJECTS

A total of 13 pilot projects have been implemented in the HGB region using a combination of federal funds and local matching funds. The resulting new transit service has resulted in reducing nearly 50 million VMT since these projects began and more than 5.2 million in 2018.

GULF COAST REGIONAL TOW AND GO PROGRAM

The Gulf Coast Regional Tow and Go Program is a quick clearance program that provides no-cost towing for vehicles that break down from mechanical failure while traveling within the City of Houston on freeways. Vehicles that break down while traveling in the program's service area are cleared, at no cost to the driver, to a safe location off the highway and within one mile. By removing obstructions from regional roadways, this program can help increase average roadway speeds and thereby reduce emissions criteria pollutants as a result of the motor vehicles. This program began in mid-2018 and over the first year provided service to over 31,000 motorists. When the program began, it covered only freeways located within the City of Houston. Since that time, this program has been expanded to include all freeways in Harris County, Texas in addition to those already covered within the City of Houston.

ACTIVE TRANSPORTATION PROGRAM

The City of Houston partnered with Harris County Precincts One and Two to jump start implementation of the Houston Bike Plan, adopted in 2017, by committing to build 50 miles of high comfort bike lanes by the Spring of 2019. With the help of additional partners like METRO, the City of Houston now has an additional 43.9 miles of high-comfort on-street bike facilities that were either complete or under construction by the end of April 2019. City staff are working with several communities to finalize plans for an additional 9.5 miles to be implemented through 2020.

The City of Houston offers approximately 270 miles of high-comfort bicycle facilities. The network includes bike lanes, bike routes, signed-shared lanes, and shared-use paths, commonly referred to as 'hike and bike' trails, which includes rails to trails, and other urban multi-use paths. In addition to these bicyclist transportation facilities, there are nearly 130 miles of hike and bike and nature trails found in City of Houston parks. In addition, Harris County and many municipal utility districts have constructed more than 160 miles of bikeways within the City limits. Houston Parks Board completed 12.54 miles of Bayou Greenways Hike and Bike Trails in 2019.

In addition to the planning efforts developed and implemented by the City of Houston, H-GAC supports communities to become more livable through planning programs and funding. Special District Studies and Livable Centers Planning Studies identify local infrastructure projects, programs, and policies that reduce VMT by improving walkway and bikeway networks, connecting community destinations, and creating

more dense communities with a higher quality of life. H-GAC has completed 37 of these studies across the region since 2004, with three studies currently underway and eleven more for the next several years.

In 2018, H-GAC also completed a preliminary dataset of all sidewalks in the HGB area. As a result, H-GAC planners and local stakeholders can now make more informed planning choices based on knowledge about existing walkway connectivity.

Walking and bicycling is increasing in our region. H-GAC has four permanent counters that measure people walking and bicycling 24 hours a day, every day. H-GAC installed two of the permanent counters in 2013 and two in 2017. These counters provide baseline data about bicycling and walking. In 2018, more than 685,000 users were counted on all four trails. Usage on all trails has increased since they were installed. The counters have shown a 249% increase in use on the Brays Bayou Greenway Trail counter, a 23% increase on the Columbia Tap Trail, a 17% increase in usage of the MKT Trail, and a 54% increase on the White Oak Bayou Greenway Trail. As our cities and counties build more infrastructure that is safe for people walking and bicycling, we anticipate that these usage increases will continue, with more people choosing to walk and bicycle for transportation as well as recreational and health purposes.

VOLUNTARY IDLING REDUCTION PROGRAM

In 2012, in partnership with local governments, citizen and environmental groups, business and industry-based organizations and other stakeholders H-GAC developed a voluntary idling reduction program and adopted a voluntary diesel idling reduction policy. This anti-idling policy aims to lower nitrogen oxide (NO_x) and other emissions by placing a five-minute idle limit on motor vehicles. Along with promoting this voluntary policy region-wide, H-GAC provides idling reduction bumper stickers and signs within our region free of charge. Port Houston has been a major partner in developing and supporting this program, posting many idle reduction signs at the Turning Basin terminal within the Port.

The following organizations within the 8-county nonattainment region have anti-idling policies in place:

Alain Garcia Independent Trucking	Danbury ISD	Jose Alfaro Independent Trucking
Alief ISD	Davenport Transportation & Rigging	Klein ISD
Alvin ISD	Dickinson ISD	Magnolia ISD
Angleton ISD	Fast Trac Transportation	Liberty ISD
AT&T	Fort Bend ISD	Museum Park Super Neighborhood
Barbers Hill ISD	Friendswood ISD	North Forest ISD
Brazosport ISD	Galena Park ISD	Our Lady Queen of Peace Catholic School
Transportation Services	Galveston ISD	Pasadena ISD
City of Galena Park	Goose Creek Consolidated ISD	Pearland ISD
City of Houston	Harris County	Santa Fe ISD
Clear Creek ISD	High Island ISD	Sheldon ISD
Columbia-Brazoria ISD	Houston Astros	Spring ISD
Conroe ISD Transportation Department	Houston Biodiesel	Sweeny ISD
Cypress-Fairbanks ISD	Houston ISD	Texas City ISD
Transportation Department	Huffman ISD	Tomball ISD
Damon ISD	Humble ISD	TxDOT
	Jacinto City	

TCEQ TEXAS EMISSION REDUCTION PLAN (TERP)

The Texas Commission on Environmental Quality's (TCEQ) regional Texas Emission Reduction Plan (TERP) program - established by the 77th Texas Legislature in 2001, through enactment of Senate Bill (SB) 5 - has been an important voluntary project in Texas. TCEQ provides TERP funding for emission reduction projects to participants in Texas. These projects include a number of voluntary financial incentive programs (including Emission Reduction and Incentive Grants, Rebate Grants, Third-Party and American Recovery and Reinvestment Act Rebate Grants, as well as other assistance programs), to help improve the air quality in Texas. Between 2008 and 2013 TCEQ regional TERP has funded more than 3,200 vehicle replacements totaling more than \$160 million dollars. During the 84th Session of the Texas Legislature in 2015, the TERP program was extended for an additional two years with a 50% increase in funding. During the most recent 85th session of the Legislature, the method of distributing TERP funding was revised in a way that will likely result in significant increases in the amount of funding available for vehicle replacements. These TERP grants are estimated to reduce between 65 and 275 tons of PM emissions per year¹⁵. Due to the new funding distribution, it is anticipated that funding, as well as expected emissions reduction related to the TERP program may increase in future years.

CLEAN AIR EDUCATION

AIR QUALITY FORECAST AND PM ACTION DAY E-MAIL ALERT SYSTEM

TCEQ provides free e-mail alerts for the Today's Texas Air Quality Forecast and PM Action Days for several metropolitan areas throughout Texas, including the Houston area. The TCEQ informs the public typically a day in advance when conditions are forecast to be favorable for high PM levels in any of the participating areas

DRIVE CLEAN TEXAS

Drive Clean Texas began in 2002 and was the nation's first statewide public outreach and education campaign designed to raise awareness and change attitudes about air pollution, reduce vehicle emissions within the state of Texas, and help drivers save money. This initiative continues to this day.

AIR QUALITY REFERENCE GUIDE

The Air Quality Reference Guide is developed and distributed by the Regional Air Quality Planning and Advisory Committee (RAQPAC). The guide provides up to date information about air pollution in the Houston-Galveston region. It is updated on a periodic basis to ensure the most up-to-date information is available to stakeholders within the region.

¹⁵ ENVIRON 2014

DUST SUPPRESSION PROJECTS IN THE CLINTON DRIVE AREA

TCEQ, EPA Region 6, the City of Houston, Harris County Precinct 2, Port Houston, Port Terminal Railroad Association (PTRA) and local industry have partnered to address PM_{2.5} sources and implement dust suppression strategies to reduce PM_{2.5} emissions near the Clinton Drive area.

TCEQ approved a supplemental environmental project (SEP) to pave the parking lot directly adjacent to the Clinton Drive monitoring station. The paving was completed in Summer 2009.

The City of Houston has installed barriers to keep trucks from driving onto the unpaved shoulder. Additionally, a traffic light was installed at Clinton Drive and Industrial Park East to control traffic. Since implementation, these dust suppression projects have proven PM_{2.5} reduction benefits (not solely PM₁₀ benefits). Speciation data from the Clinton Drive monitor show decreases in dust and soil following the implementation of dust suppression measures.

Port Houston has established a program to regularly apply emulsified asphalt to reduce dust emissions at Industrial Park East (IPE) at the Turning Basin Terminal (since 2007). Port Houston has also paved 18 acres of land and all of the roadway at IPE. Since 2008, Port Houston has sprayed approximately 48 acres with emulsified asphalt. Additionally, DuPont, a previous tenant, no longer stores bulk fluorspar at IPE. While all the roads at IPE are now paved, the tenants' properties at IPE are still unpaved. Although they are sprayed with emulsified asphalt, standing water after a heavy rain can still cause dirt to be tracked out on the paved roads. To help with this, Port Houston is now improving the IPE storm water drainage infrastructure. Additionally, the areas inside the warehouses at IPE are not paved so Port Houston has started to pave these areas.

In the western part of the Turning Basin Terminal, Port Houston has also reconstructed the High Level Road at Turning Basin, which added capacity from two lanes to four lanes from the main entry gate off of I-610 to the Port Coordination Center. Before the reconstruction of High Level Road, trucks would pass other trucks that were stopped to make a turn by traveling in the dirt shoulder which would create dust. The widening of the road to 2 lanes each direction eliminates this practice and has reduced dust created from shoulders. Furthermore, the Port operates sweepers (about 1,600 hours a year) on High Level Road and have been working on an ongoing basis with the port's tenants to eliminate the dirt that is tracked out from their leased yards onto High Level Road.

In addition, industry has undertaken dust suppression efforts near the Port. The PTRA has relocated steel loading activities from a dirt area to the south of the Clinton Drive monitor to another location in order to reduce dust. Valero Asphalt paved its large land leases located across Clinton Drive to the southeast of the Clinton monitor.

CITY OF HOUSTON

RENEWABLE ENERGY

The City of Houston is the largest municipal purchaser of green power in the nation with more than 89% of the City's energy supply coming from either wind or solar sources. In 2017, the City expanded its portfolio with the addition of a 50 MW solar power purchase agreement which allows 100% solar power

to be used at City facilities such as the Houston Zoo, the Bob Lanier Public Works Building, passenger terminals at IAH, and wastewater treatment plants.

CLIMATE ACTION PLAN

In conjunction with the Houston Advanced Research Center (HARC), the City has been developing its first community-wide Climate Action Plan (CAP). On April 22, 2020 – the 50th anniversary of Earth Day – the City launched the science-based, community-driven Houston Climate Action Plan to reduce greenhouse gas (GHG) emissions, meet the Paris Agreement goal of carbon neutrality by 2050, and lead the global energy transition. This plan will act as a roadmap for the City, businesses, residents, and communities to reduce their greenhouse gas (GHG) emissions and meet the goals of the Paris Agreement to be carbon-neutral by 2050. The CAP will analyze current emission sources and calculate the health, safety, and economic benefits of various development and policy options that could bring Houston closer to a carbon neutral future. As sustainability and resiliency go hand in hand, the plan is also a critical component of the City's overall recovery efforts after Hurricane Harvey.

Development of the CAP was achieved through numerous public stakeholder meetings, working group meetings, and numerous individual discussions. Four working groups have proposed initial recommendations on goals and strategies to reduce emissions across Houston's four largest categories of emissions – transportation, buildings, decarbonization, and waste. These recommendations are currently under review by City of Houston departments and the Mayor's Office.

GHG REDUCTION GOAL

The City of Houston has set a strong example of how to combat climate change and lower emissions in the Energy Capital of the World. Since 2005, the City has reduced municipal emissions by 37%, through building efficiency upgrades, investing in renewable energy, and converting to hybrid, electric, and alternate fuel vehicles. As co-chair of Climate Mayors, Mayor Turner and the City of Houston helped garner over 412 U.S. Mayors to commit to upholding the Paris Agreement.

GREEN POWER PROGRAM

As the 4th largest city in the United States, the City of Houston uses large amounts of power. The goal of the City's Green Power Program is to demonstrate that if a city the size of Houston can one day reach 100% green power, then other cities can as well. Houston has been the number one municipal user of renewable energy by the EPA and today powers 90% of municipal facilities with renewable energy. In FY 2019, the City of Houston used nearly one billion kilowatt-hours (kWh) of green power including solar and wind energy.

As a result, for the 6th year in a row, Houston was named the #1 municipal user of green energy in the nation by the United States Environmental Protection Agency (EPA). Houston is also ranked #17 on the EPA's overall Top 100 green power users. By investing in green power, the City strives to drive further investment and development in the renewables market and make green power even more affordable and accessible for everyone.

In April 2020, Mayor Sylvester Turner announced that the City of Houston has committed to purchasing 100% renewable energy through a renewed partnership with NRG Energy as the City's retail electric provider.

SOLAR POWER PURCHASE

On Earth Day 2017, the City launched its first power purchase agreement (PPA) for a 50 MW solar facility in Alpine, TX. This represents just over 10% of the City's power consumption and provides buildings such as the Houston Zoo, the passenger terminals at Intercontinental Airport, 611 Walker, and some of Houston's wastewater treatment facilities with clean solar energy. In exchange for increasing the PPA from 30 to 50 MW, the overall contract price was reduced by 8%, resulting in an estimated \$40 million of savings over the 20-year term of the PPA.

EVOLVE HOUSTON

Formed as a realization of the City's Climate Action Plan, EVolve Houston is a coalition of civic and business leaders who are sustainability-minded and aim to accelerate clean transportation and zero-emission goods transportation through electrification. EVolve Houston aims to improve regional air quality and reduce greenhouse gas emissions by motivating the transition to electric vehicles across varying sectors in the Greater Houston Area.

Mayor Turner has stated that "EVolve Houston and its members are key to implementing the ambitious goals outlined in the City of Houston's Climate Action Plan and Resilience Strategy."

Potential actions include (but are not limited to) entering into partnerships that boost awareness, affordability, and availability of electric vehicle models; planning present and future vehicle charging infrastructure; electrifying both public and private vehicle fleets; and deploying electric vehicle pilots. The coalition is currently working to support several electrification projects around the City, including developing a public vehicle charging infrastructure strategy and the evaluation and integration of electric vehicles into the City's municipal fleet. EVolve Houston is also assisting consumers and fleets with identifying funding opportunities for purchasing electric vehicles and charging infrastructure.

On May 20, 2021, the City announced that it will install electric vehicle charging stations in a number of City facilities. The City plans to convert an estimated 8,000 non-emergency city-owned vehicles to electric vehicles.

REINVENTING CITIES

The Reinventing Cities Challenge works towards encouraging renewable and zero-carbon projects in Houston. The goal of Reinventing Cities is to take under-used city property and challenge the best and brightest minds to redesign, reimagine, and reinvent how they can be used in a sustainable way. In 2019, Mayor Sylvester Turner announced that Sunnyside Energy won a competition to repurpose a former landfill in the Sunnyside neighborhood of Houston. Subject to meeting certain terms and conditions, the team will construct one of the largest urban solar farms in Texas.

On January 14, 2021, the City approved a lease agreement with Sunnyside Energy, LLC to advance the Sunnyside Solar Project—an innovative public-private partnership to convert the 240-acre closed landfill in Sunnyside into the largest brownfield solar installation in the nation. The project is a product of the City's Climate Action Plan and Complete Communities Initiative. It is an example of how the City of Houston is working to find innovative, public-private solutions to addresses historic environmental justice concerns, climate change, and economic development in underserved communities.

PROPERTY ASSESSED CLEAN ENERGY PROGRAM

Initially created in 2016, the City of Houston's municipal Property Assessed Clean Energy Program (PACE) provides an additional tool for Houston property owners to finance energy efficiency, renewable energy, and water conservation projects. In 2017, the City announced Houston's first PACE project which, at just over \$2 million, was the largest PACE project in Texas at that time. Thus far, PACE projects have invested \$3.6M into the Houston economy, created 24 jobs, reduced 1,729 ton/year of CO₂, saved 9.6 gallons of water/year, and saved 3.3M kWh/year of electricity.

RESIDENTIAL ENERGY EFFICIENCY PROGRAM (REEP)

In conjunction with CenterPoint Energy, the City's Sustainability Office is providing up to \$5 million/year in targeted energy efficiency improvements to low-income, multi-family housing complexes being redeveloped following Hurricane Harvey. Houston Housing and Community Development is currently reviewing project candidates. Additional complexes will be added to the program each year, in conjunction with the City's \$315 million housing development program.

ENERGY EFFICIENCY

Since 2004, the City has required all new buildings to be LEED Certified. The City currently has 37 LEED buildings with plans to add more through 2020. To date, the City has invested \$70 million in energy efficiency retrofits: 6 million square feet of retrofitted City facilities are expected to achieve guaranteed energy use reductions of 30%, saving over 22 million kWh of electricity every year. The City's most recent retrofitting projects were in the Parks and Recreation Department and in the Library Department where 18 libraries were retrofitted. Green Buildings and Energy Efficiency

For City buildings, there is an aggressive program in place to improve energy efficiency. So far, 6 million square feet of city facilities have been retrofitted and are reducing energy usage by 30% each year. The City has also committed to improving energy efficiency by 20% at an additional 30 million square feet of facilities. The City has adopted an aggressive stance on the creation of LEED certified buildings targeting Silver certification for all new construction. So far, this has resulted in the completion of 31 LEED certified projects with another two currently being planned.

SMART CITY STREETLIGHT INITIATIVE

In September 2019, the City will deploy a small proof-of-concept pilot to install five LED streetlights as its first ever complete City-installed and -owned streetlighting system. The installation is planned along the Tierwester Road realignment project. Streetlights will be equipped with sensors and advanced lighting controls that will be programmed to allow lighting levels to be dimmed for energy savings and increased for pedestrian safety crossing. A unique capability of the controls will be the ability to expand existing Wi-

fi coverage. The controls will also provide the City with an advanced streetlight asset management system. Aluminum poles will be used for their sustainability.

An air quality monitoring system to gather real-time air quality data will also be installed on one of the streetlights. Among the key data collected will be ozone, particulate matter, nitrogen dioxide and humidity. There are several stake holders who will benefit from this information including air quality professionals, community groups, educators, health and safety managers and researches. This environmental data will be available to analyze and will showcase the attractiveness of living, working, and investing in Houston.

EPA GREEN POWER PARTNER

The City of Houston was the recipient of the 2017 Green Power Leadership Award from the U.S. Environmental Protection Agency (EPA). EPA's annual Green Power Leadership Awards recognize America's leading green power users for their commitment and contribution to helping advance the development of the nation's voluntary green power market. Houston has received the award previously in 2008 and 2014.

In June 2021, the Environmental Protection Agency recognized the Houston region as a national leader in energy innovation across multiple categories. EPA announced that Houston has more ENERGY STAR-certified buildings than any other city in Texas, ranking seventh in the country. According to the EPA, last year, the Houston-Sugarland-The Woodlands area's 195 ENERGY STAR certified commercial and multifamily buildings saved more than \$41 million and 242,992 metric tons of carbon dioxide emissions, equivalent to taking nearly 53,000 passenger vehicles off the road.

TEXAS SOUTHERN UNIVERSITY AUTONOMOUS SHUTTLE

In June 2019, Texas Southern University began piloting an autonomous vehicle (AV) electric shuttle bus in partnership with METRO, the City of Houston, and the Houston-Galveston Area Council. In the first phase of the pilot, METRO will operate the bus on a one-mile roundtrip route connecting East and West campus with three stops. The pilot will assess the physical and operational characteristics of the bus, as well as conduct surveys to evaluate stakeholder and community engagement. The second and third phases of the pilot, will extend the shuttle's route. The project aims to test and support AV technology that can provide reliable "first-mile/last-mile" links to local transit.

PARKING GUIDANCE SYSTEM

In 2016, ParkHouston was awarded \$3.2 million in Congestion Mitigation and Air Quality program funding for a parking guidance system. This system provides real-time on- and off-street parking information to guide the traveling public to available parking spaces quickly and efficiently. The project also provides directions from main access roads through dynamic and fixed messages signs, a website, and/or a mobile application. The project aims to reduce traffic congestion, saving energy and vehicle pollution, while also improving mobility and the parking customer experience.

LED LIGHTING CONVERSION PROGRAM

In 2014, at the City's request, CenterPoint Energy began converting ~175,000 streetlights to LED technology. This project is intended to reduce the City's streetlight energy usage by approximately 50%, while reducing the City's greenhouse gas emissions by 5%. Although the project was supposed to take several years, thanks to overwhelming support from residents asking for lighting to be installed in their neighborhoods and a push to light up the city in time for the Super Bowl, CenterPoint Energy is ahead of schedule.

The Public Works Department also finished replacing the incandescent bulbs at all 2,450 signalized intersections with LEDs and the City is now realizing over \$3.6 million a year in savings.

"SMART FLEET" MUNICIPAL FLEET AIR QUALITY MONITORING PROJECT

In partnership with the Houston Health Department (HHD), the Environmental Defense Fund (EDF) implemented a "smart fleet" pilot to test a cost-effective, scalable model for mapping air pollution using municipal vehicles. An analysis of over one million connected vehicles, published by EDF & Geotab, indicates that just 10 vehicles could map over 50% of a city without altering their normal routes. Prior to this pilot, air pollution mapping using vehicle-mounted sensors has required expensive equipment, special-purpose vehicles, time-consuming hands-on instrument management, and special-purpose routes. In contrast, the Houston Smart Fleet pilot used rugged, low-cost instruments mounted on municipal vehicles. HHD vehicles collected and transmitted data in real time, demonstrating a new model for cities to actively monitor air quality using existing assets. EDF is now working with Rice University to analyze data from the pilot, and EDF and the City are building on this data collection model to develop a "Control Chart" tool that the city could use to identify air pollution patterns of interest for enforcement of existing pollution policies and design of new ones.

GREEN FLEET STUDY

The City was awarded a \$75k grant from Rice University/Kinder Foundation for a green fleet study with the Houston Solutions Lab, to be completed in Fall 2019. This study will help the Fleet Department determine when to replace COH fleet vehicles and what type of fuel would be most emissions and cost efficient. The goal of the study is to create a pathway to a 100% electric fleet for all non-emergency passenger vehicles.

GREEN FLEETS

Through the City's Houston Drives Electric program, Houston has become a leader in government electric vehicle (EV) fleets. Through this program, the City has recently added 27 Nissan Leafs to its vehicle fleet for a total of 3742 electric and plug-in hybrid fleet vehicles and 526 conventional hybrid vehicles. In addition to the purchase of these more efficient vehicles, the City has created the Houston Fleet Share program to serve as a central, shared motor pool. This has resulted in a 50% increase in vehicle utilization with more needs met using fewer vehicles. As a result, 44 older and less efficient vehicles have been sold and 84 others have been reassigned.

Participation in Department of Energy's (DOE) EV Project, with partner Ecotality, added 77 additional Blink charging stations in Houston, including 24 at the airports and 29 in downtown Houston. Through this program participants, including the City of Houston and other businesses, received charging stations at no cost and an additional credit to install the charging station. In addition, the City has offers 24-hour permitting for residential charging stations and is working on additional incentives to spur the adoption of EV technology.

On May 12, 2021, the City announced that it will purchase, install, and deploy electric vehicle (EV) charging stations in various City facilities. The effort will be enabled through the City's partnership with Greenlots, a leading EV charging solutions provider and member of the Shell group, and driven by the Houston Climate Action Plan.

SUSTAINABLE FLEET

Prior to Hurricane Harvey, Houston had the 4th largest municipal hybrid fleet in the nation. Approximately 50% of the City's non-specialty, light-duty fleet have been replaced with hybrid vehicles to reduce current and future maintenance costs, increase vehicle reliability, and decrease emissions. Overall, about 11.5% of the City's fleet is green and the City plans to use funding from the VW settlement to add more alternate fuel and electric vehicles to the City's fleet.

Unfortunately, due to severe flooding within the parking garages under City Hall, nearly all of the City's Electric Vehicle fleet were destroyed. However, thanks to the support of Nissan, the City plans to add 29 EVs back in the City's fleet. As one of the 11 cities selected under the Electrify America program, the City of Houston is working with local businesses and neighborhoods to expand public EV infrastructure throughout Houston.

ANTI-IDLING POLICIES

As a result of Houston's efforts during 2018 -2019 to reduce air emissions via Houston's anti-idling ordinance involving outreach and enforcement the HHD Bureau of Pollution Control and Prevention (BPCP) received 50 Idling Complaints.

In addition, during the months of June – July 2018, members of the BPCP Engineering Department visited more than 40 truck maintenance yards on the north part of the City and issued four Notice of Violations (NOV's) for trucks idling for more than 5 minutes. As a result of one of the NOV's issued to one of the Truck Maintenance Sites, the facility Installed a Billboard sign on their fence outside their business to enforce the Idling Ordinance in their property.

CONCRETE BATCH PLANTS

There are approximately 180 concrete batch plants (CBP's) in the Houston area – twice as many as Dallas and the most of any area in Texas. A concrete batch plant is a facility that produces concrete. These facilities mix cement, sand, and water to make concrete and load it into trucks for delivery. If not properly controlled, these operations can expose residents to large amounts of particulate matter (fine dust). Particulate matter is a dangerous and widespread air pollutant that is associated with causing cardiovascular and respiratory

harm, cancer, and premature death.¹⁶ Particulate matter produced during concrete batch plant operations may contain crystalline silica and metals.¹⁷ The City of Houston conducted inspections and investigations at concrete batch plants that identified violations of air quality and nuisance standards including but not limited to, the lack of use of adequate dust controls and visible emissions leaving property lines among the most frequent. Given the increasing number of concrete batch plants in our region, efforts should be made to collaborate with the cement industry to ensure best practices are implemented to protect the public health of communities.

CBP's emit particulate matter pollution within the city limits, often in close proximity to residences, schools, parks, and other public places. These sources are a concern for the community and result in numerous 311 complaints. The BPCP has been seeking stronger permitting requirements thru numerous permit comments submitted to the Texas Commission of Environmental Quality (TCEQ) to reduce particulate matter emissions and restrict locations. The City continues to conduct site inspections of concrete batch plants, which may include deployment of a mobile laboratory, and continues to develop training programs to help citizens recognize compliance problems created by CBP's facilities including those that may fail to meet the current permit by rule compliance criteria. In addition, the BPCP has supported City of Houston citizens in CBP's Public Meetings and Hearings.

ENERGY EFFICIENCY AT THE AIRPORTS

Improving air quality through the use of alternative technologies is a priority of the Houston Airport System. The Houston Airport System is working to upgrade and renovate outdated infrastructure and equipment at the William P. Hobby and George Bush Intercontinental Airports. The projects include installing four new chillers, improving building operations, and installing a solar array on new shading canopies. The implemented projects will reduce annual energy consumption by more than 24 million kWh and utility costs by more than \$1.3 million. This will also help the Houston Airport System to reach its "net-zero" energy goal for George Bush Intercontinental Airport.

The Texas A&M Engineering Experiment Station Energy Systems Laboratory will manage project design and construction. The majority of funding will come from the LoanSTAR Program; which is administered by the State Energy Conservation Office of the Texas Comptroller's Office.

HOUSTON AIRPORT SYSTEM EMISSIONS REDUCTIONS

Houston Airport System has initiated a variety of efforts at both George Bush Intercontinental Airport (IAH) and William P. Hobby Airport (HOU) in order to mitigate particulate matter emissions. Some of these strategies include conversion of power sources from diesel to compressed natural gas or electricity, methods for reducing fuel consumption, and improved routes to combat vehicle idling and traffic congestion, among others.

Ground support equipment (GSE), including luggage loaders and aircraft tugs, at IAH and HOU have been converted from diesel-powered to run on electricity, reducing the use of conventional fuels. EcoPark Parking Shuttles operating between airport terminals and long-term parking facilities at IAH that were formerly running on diesel are now being powered by Compressed Natural Gas (CNG). An above-ground automated people-mover (skyway) has been installed at IAH, which has eliminated the need for diesel-

¹⁶ U.S. Environmental Protection Agency, *Integrated Science Assessment for Particulate Matter*, December 2009. EPA 600/R-08/139F

¹⁷ <https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s12.pdf>

powered buses operating between airport terminals, thereby reducing fuel consumption and travel time. Additionally, an aircraft hydrant fuel system (HFS) that utilizes passenger gates has been installed, eliminating the need for diesel-powered fueling trucks that travel between aircraft at the terminal and the fuel storage facility, further diminishing fuel consumption.

The staging and routes for limousines in the terminal areas of IAH, as well as the Ground Transportation Center for taxis, Super Shuttles, Cruise Line Buses, and Passenger Arrivals and Cell Phone Lot, have all been improved in order to reduce idling and travel times. The use of the Consolidated Rental Car Facility (CRCF) has significantly reduced the annual vehicle miles traveled by car rental shuttle buses simply by reducing the travel routes to the CRCF. The large number of diverse buses previously operated by the car rental firms have been replaced by a small number of clean diesel buses. Parking garages at HOU, and eventually IAH as well, now have guidance systems that display available parking space and signage LEDs to guide the driver to the nearest empty spot to improve traffic flow, and reduce congestion, and drive time looking for a parking spot.

Auxiliary power units (APUs) are small on-board turbines or gate-side diesel generators that are operated to provide electrical power and air conditioning to an aircraft when it is parked at a gate and its main engines are shut down. Preconditioned air and centralized 400 Hz power hookups have been installed at all gates at IAH and HOU to replace APU usage when aircraft are parked. These systems rely on grid power provided by electric utilities. While aircraft are hooked up to these external connections, the APUs are not operated, eliminating PM emissions during these times. Furthermore, the Houston Airport System adopted the Leadership in Energy and Environmental Design (LEED) certification standards for new construction of city-owned facilities.

In addition, the Houston Airport System has initiated a number of other projects which will result in PM emission reduction. For example, central utility plant improvements at IAH include: state-of-the-art emissions controls, a new hot water heating system to reduce fuel consumption and the corresponding emissions, additional electric chillers to reduce the use of steam chillers, solar photovoltaic array supporting the Control Room and Administration Building, implementation of energy conservation initiatives, and optimization of the HVAC thermal and distribution systems. HOU continues to implement central utility plant improvements, including implementation of energy conservation initiatives, emission reduction strategies, and upgrades to chillers and the chill water system. HAS is also planning a major project for the conversion of steam chillers to electric chillers that is expected to result in significant emissions reductions through elimination of gas boilers.

There are a variety of other efforts planned by the Houston Airport System that will work towards PM emission reduction. Lighting at IAH and HOU are being retrofitted with LED bulbs that will lower energy costs and reduce energy usage. Furthermore, the Houston Airport System will focus on returning HVAC equipment at IAH terminals to optimal performance, reducing excessive run-times and optimizing use. Updates to building controls allow for better management of terminal-level equipment and improve ability to troubleshoot and prevent failures. Coils in Air Handling Units at IAH are being replaced with Variable Air Volume systems which will balance out ventilation, and a solar photovoltaic array is planned at HOU's Red Garage - both efforts that will reduce air emissions. The Houston Airport System is also planning to introduce native landscaping at Ellington Airport, HOU, and IAH.

BIKE SHARE PROGRAM

In 2015 the City of Houston was awarded a federal grant to expand Houston BCycle. This funding allowed BCycle to more than triple the size of bike share in Houston. Currently, BCycle has 92 stations, 635 bikes and 2 transport vehicles in their existing bike share network. The network has expanded to include stations in Midtown, Downtown, Montrose, Texas Medical Center, Rice University, University of Houston, Texas Southern University, Greater Heights, Woodland Heights, Memorial Park, Third Ward, Second Ward, East Downtown, Washington Avenue, Buffalo Bayou Park, Museum District, Memorial City, and Near Northside. Implementation of the project began in early 2017 and is still ongoing.

The program is reaching new heights in ridership—with more than 260,000 trips projected by the end of 2019 and more to come as expansion continues. This projected total would be more than a 60% increase from 2018's record-breaking number. Commuter trips (one-way) now comprise more than 55% of all trips taken.

HOUSTON BIKEWAYS

The Houston Bikeways Program is a collaborative effort to improve safety, accessibility, ridership, and maintenance of bike facilities in Houston. The program initially began as an internal partnership between the City of Houston's Planning & Development, Public Works, and Parks & Recreation departments during the Houston Bike Plan process. It has now evolved to include many other internal city departments and several external organizations. Each organization plays a critical role in ensuring Houston achieves its vision of becoming a safer, more accessible Gold level bike-friendly community. Houston Bikeways offers a 345-mile interconnected bikeway network spanning across 500 square miles of the city. The network includes bike lanes, bike routes, shared lanes and bayou trails, rails to trails, and other urban multi-use paths.

SAFE PASSAGE ORDINANCE AND COMPLETE STREETS POLICY

The City of Houston approved a Safe Passage ordinance in May 2013 to keep bicyclists and pedestrians safer on city streets and encourage more outdoor activity. In November 2013, Mayor Parker signed the Complete Streets Executive Order, which unveiled a transformative new policy for Houston streets to accommodate the needs of all users, not just those behind the wheel. The Complete Streets and Transportation Plan is meant to provide safe, accessible, and convenient use by motorists, public transit riders, pedestrians, bicyclists, and people of all ages and abilities.

In 2014, the City and BikeHouston created a bike safety campaign, Goal Zero, to enforce and educate motorists and cyclists about the Safe Passage Ordinance. Houston City Council adopted the Houston Bike Plan in March 2017. A key goal of the Bike Plan is to provide a safer bicycle network for people of all ages and abilities through improved facilities, education, and enforcement. In March 2018, an innovative partnership between Harris County and the City of Houston allotted \$30 million to improve seven streets in the City of Houston near the University of Houston and the Texas Southern University Corridor. This funding will help to improve and build additional sidewalks, repair drainage, and help reduce street flooding. Moreover, it will add additional bike lanes to the Third Ward area and provide students with mobility options to get around by either walking, biking, or driving.

The Complete Streets program compliments Mayor Sylvester Turner's Complete Communities initiative, which was announced on April 12, 2017 and improves neighborhoods so that all of Houston's residents

and business owners can have access to quality services and amenities. Additionally, in 2018, Mayor Turner announced a safety initiative to research the top 10 most dangerous street intersections in Houston. A total of 12 intersections were researched by the City of Houston, in partnership with the Federal Highway Administration (FHWA). Upon completion of the study, the FHWA recommended both long and short-term safety improvements; many of the short-term recommendations have already been implemented.

FCC RECYCLING FACILITY

FCC, an environmental services and infrastructure firm, opened a new, state-of-the-art Material Recycling Facility in northeast Houston that will process around 65,000 ton/year of recyclable materials – including glass, aluminum, plastics, and metals. The facility has a total capacity of 145,000 ton/year and will operate for at least the next 15 years.

METAL RECYCLERS TASK FORCE (MAPPS)

The City continues to collaborate with researchers from the University of Texas Health Science Center at Houston School of Public Health (who are in the lead) and Rice University, area metal recycling facilities, community members, and Air Alliance Houston in a project to study and address potential health risks associated with air emissions from metal recycling facilities in Houston.

This is a three-phase project. Phase 1 of the project consists of collaborators working to conduct outdoor air monitoring, determine health risks and describe residents' environmental health concerns. Phase 2 of the project consists of development and application of a Public Health Action Plan to recommend best emissions-mitigating-practices and educate the community, metal recyclers and policy makers about environmental health. Phase 3 of the project consists of follow up activities to evaluate the effectiveness of the Public Health Action Plan. Phase 2 is currently being completed.

BAYOU GREENWAYS 2020

The Houston Parks Board launched an initiative to create 150 miles of trails and bridges that will connect Houston's major bayous by 2020, such that 1.5 million Houstonians will live within 1.5 miles of the Bayou Greenways. \$100 million in funding, plus \$170 million in additional private and nonprofit support, has been set aside for this project.

VOLUNTARY ENVIRONMENTAL COMPLIANCE AGREEMENTS

The City and industrial businesses have voluntarily implemented environmental compliance agreements that help reduce emissions. By these agreements, businesses have modified operational controls minimizing particulate and visible emissions, such as from painting and abrasive blasting operations in the ship channel area.

HARRIS COUNTY

OFFICE OF SUSTAINABILITY

On July 20, 2021, the Harris County Commissioners Court established a new Office of Sustainability to develop equitable sustainability and resiliency policies and practices to protect all Harris County residents, with special consideration of climate and environmental justice. As a part of their scope of work, the Office will work closely with County departments in the development, coordination, and administration of a County-wide, equity-centered Climate Justice & Action Plan. Additionally, the Office of Sustainability will be responsible for coordinating community engagement and assistance to climate and environmental justice communities as well as planning initiatives with departments to accomplish sustainability and resilience within the County, including: green purchasing, recycling, transportation and fleet management, smart technology integration, waste management and diversion, and energy and water efficiency.

RENEWABLE ENERGY

On October 20, 2020, the Harris County Commissioners Court agreed to formally opt out of the Public Power Pool's 2023 procurement proposal to pursue diverse options for future procurement of energy. Harris County intends to use this opportunity to update its power purchasing to minimize cost and maximize environmental benefits, focusing on renewable and green energy options. Currently, Harris County is in process of procuring renewable energy, including potentially a mix of onsite and offsite renewable assets.

COMMUNITY AIR MONITORING PROGRAM

In September 2019 Harris County Commissioners Court approved funding for the Harris County Pollution Control Services Department (PCS) to establish a community air monitoring program (CAMP). This program is designed to collect ambient air data throughout Harris County and provide that data in near real-time on PCS web site to augment the existing Particulate Matter (PM) and Volatile Organic Compounds (VOC) monitors with additional sampling sites. The ultimate goals of the program are to:

- Provide ambient monitoring in areas currently lacking data
- Identify areas to focus on for source identification
- Identify non-compliance issues
- Reduce both VOC and PM pollution

To date, PCS has established 11 active CAMP sites throughout Harris County and plans to soon deploy a Rapid Ambient Air Monitoring (RAAM) van for monitoring both during times of disaster and "blue-sky" days. In addition, multiple portable monitors have been acquired enabling PCS to monitor multiple air pollutants.

CONCRETE BATCH PLANT INITIATIVE

There are approximately 135 concrete batch plants (CBP) in Harris County. CBPs are known to produce fine particulate, airborne waste that generates a significant amount of citizen concerns and/or complaints. In early 2020 PCS implemented an initiative to regularly inspect the CBPs operating within Harris County's jurisdiction to better ensure compliance with air and stormwater quality permits and committed two full-time investigators to the project.

Since implementation through June 2021, PCS has investigated a majority of the CBPs in Harris County and issued 130 violation notices. PCS has identified additional sites for future inspections. Furthermore, in addition to CBP inspections, PCS continued to submit comment letters to the Texas Commission of Environmental Quality (permitting authority) requesting stronger permitting language and additional controls for CBP operators in the effort to reduce PM emissions and hold violators accountable.

In March 2020, Commissioner Rodney Ellis requested that PCS work to enhance community engagement efforts in neighborhoods with high concentrations of concrete batch plants to inform residents about the associated health risks, as well as how to recognize and report potential violations. To date, PCS' Communications section has reached out with over 1500 letters transmitted to citizens regarding CBP permitting actions.

ELECTRIC VEHICLE FLEET

PCS staff travel approximately 65,000 miles a year while conducting investigations and other county business. Until recently, travel was by way of conventional fuel burning vehicles. In February 2021 PCS acquired 12 electric vehicles (EV) and 7 hybrid vehicles for PCS staff to utilize for the investigative work. The utilization of the fleet has begun, and continues, to reduce PCS' NO_x, CO, PM and VOC footprint in addition to saving on fuel costs.

In collaboration with PCS, Harris County Universal Services (US) coordinated the installation of six level two charging stations to accommodate the 12 EVs PCS acquired. US also received grant monies for the installation of five additional locations and is currently assessing where these locations would be the most advantageous. US continues to look into replacing other light duty vehicles with Hybrids to further lower HC's emissions footprint and improve efficiencies.

HARRIS COUNTY ENGINEERING DEPARTMENT GREEN VEHICLE PILOT STUDY

In 2019, Harris County Engineering Department committed to moving towards a "greener fleet" whenever vehicles were replaced or new vehicles were acquired. As result of adding 22 more efficient vehicles to the Fleet in calendar year 2019, HCED has realized a fleet-wide average 25% increase in the EPA Estimated City MPG, 14% increase in Highway MPG, and 17% increase in the Combined MPG. As department staff drove an average of 2.5 million miles/year over the last two years, the increases in fuel efficiency have surely led to a decrease in local air pollution impact. The Engineering Department intends to continue looking for opportunities to continue to green the county's fleet as vehicles are replaced in upcoming years.

HARRIS COUNTY TOLL ROAD AUTHORITY (HCTRA)

On July 28, 2020, Commissioners Court authorized the Harris County Toll Road Authority (HCTRA) to accelerate planning and development for conversion of toll road operations to an All Electronic Tolling (AET) system. The timing of this transition was originally envisioned to occur prior to calendar year 2026, however, a more truncated timeline is now recommended as cash collection on HCTRA roadways has been suspended as a safety precaution due to the COVID-19 pandemic. Engineering consultants have been engaged to develop preliminary plans for the transition, including an updated timeline and the eventual removal of the six toll plazas designed for cash collection. The conversion to an AET system aims to not only increase safety, but to decrease congestion and reduce idling and emissions by eliminating chokepoints at the toll plazas.

HOUSTON BCYCLE EXPANSION PROGRAM

The Houston Bike Share program received a \$276,293 LIP grant and used matching funds in the amount of \$276,293 for a total project budget of \$552,586. The grant was used to expand the BCycle program by 39 stations and additional 325 bikes. The grant was awarded in February 2017 and closed in December 2018.

The program is very popular. In 2019 the City of Houston provided additional funds to expand the program to over 100 stations and 700 bikes. In April 2020 Commissioners Court authorized \$842,700 to build an additional 30 stations and provide 320 Electric Bikes.

METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY

LIGHT RAIL EXPANSION & NEW BUS NETWORK

The Metropolitan Transit Authority of Harris County (METRO) operates three light rail lines, 83 local bus routes, and 14 Park & Ride bus routes as part of its fixed-route system. In FY2019 METRO operated 34 Park and Ride bus routes. In response to previously declining ridership trends related to the COVID-19 pandemic, METRO consolidated Park and Ride routes in each corridor. METRO continues to adjust Park and Ride service commensurate with ridership increases and guidance from the local, state, and federal governments. Included in the 83 local bus routes noted above are three Community Connector routes. The original 7.5-mile METRORAIL Red light rail line opened in January 2004. The additions of the North Line light rail extension in December of 2013 and the opening of the METRORAIL Green and METRORAIL Purple Lines in May 2015 have increased the light rail system's total mileage to 22.5 miles. These openings contributed to an increase in annual boardings on METRORail by 64% from FY2013 to FY2019. Unfortunately, the COVID-19 pandemic negatively affected METRORail ridership in FY2020. METRO realized a 30% decrease in METRORail ridership in FY2020 compared to FY2019. This decrease was largely driven by the absence of in-person school at the University of Houston and Texas Southern University, as well as, the decision of many Central Business District based employers to allow employees to work from home. Additionally, METRO implemented a complete overhaul of the local bus network (termed "New Bus Network") in August 2015 to curtail declining ridership and improve service by moving to a frequency-based network. By the close of FY2019, local bus ridership had increased by 1% over FY2016. In FY2020, however, the combination of Harris County's "Stay Home, Work Safe" advisory, emphasis on travel for essential purposes only, and implementation of reduced maximum passenger loads for social distancing were all factors which impeded ridership. METRO realized a 23% decrease in ridership for the local bus network in FY2020 as compared to FY2019.

METRORAPID SILVER LINE

From boarding at elevated platforms similar to rail to cruising past traffic in dedicated, bus-only lanes, riders will notice a smooth, rail-like experience, the METRORapid Silver Line began carrying customers on Sunday, Aug. 23, 2020. The Silver Line connects the Northwest Transit Center, north of Interstate 10, to the new Westpark/ Lower Uptown Transit Center. The five-mile 10 station METRORapid route is the region's official introduction to bus rapid transit (BRT) technology.

With service that runs every 10 minutes during the day, the Silver Line is ideal for riders who live, work and shop in the Uptown area or for those who want a convenient connection to the rest of METRO's transit network. The hours of operation are 5 a.m. to midnight, seven days per week.

The Uptown Houston District led construction of the project along Post Oak Boulevard and METRO will operate the service. The other project partners include the Texas Department of Transportation, the City of Houston and the Houston-Galveston Area Council.

BUS FLEET

As of September 30, 2020, METRO operated a fleet of 1,220 buses devoted to fixed-route service, which handled 67.4 million boardings in Fiscal Year 2018.¹⁸ The fleet includes 424 clean running, diesel-electric hybrid technology buses (35% of the fleet) and an additional 50 compressed natural gas (CNG) buses (5 of the fleet), both of which contribute to PM reductions for the HGB region. The fleet also includes 14 60' buses that will be used exclusively for the METRO Rapid Silver Line route.

METRO BIKES ON BUSES

There are a growing number of bicycle and pedestrian paths and walkways and a concentrated effort to connect these walkways with activity centers and transit nodes. All METRO buses are equipped with bike racks, with the exception of park and ride buses (which have cargo areas for bike storage). METRO's annual bike boardings continued to increase from 2011 through 2018, however, FY2019 (277,738 Bikes on Buses) saw a 2% decrease from the all-time high in FY2018 of 283,019 bikes. In FY2020, as the number of passengers on METRO vehicles declined primarily due to COVID-19, so did the number of bikes on buses. In FY2020, the bike boardings totaled 187,514, a 32% decrease from the previous fiscal year.

METRO STAR VANPOOL PROGRAM

STAR, the regional vanpool and rideshare program provided by METRO is one of the largest programs of its kind in the nation. The program provides a 7-15-seat passenger vans for use by groups of 5 to 15 riders along with insurance, maintenance, roadside assistance and administrative coordination. Average daily fares range from four to eight dollars, and the average round-trip is 58 miles. Additionally, program participants benefit from a capital subsidy (the average for 2017 was \$429 per van per month) toward the cost of the vehicle to help offset vanpool costs. Volunteers within the vanpool groups do the driving. For the last fiscal year of 2017, there was an average of 592 vanpools in operation with more than 6,042 riders in the region. This program reduced nearly 52 million VMT in 2017.

PORT HOUSTON

BAYPORT EXPANSION AND INCREASED EFFICIENCY

Port Houston was awarded a \$10 million Transportation Investment Generating Economic Recovery (TIGER) grant in 2013 to be used toward the expansion of the berth at its Bayport Container Terminal. The grant is funding the extension of Bayport's wharf and the purchase of three new all-electric, rail-mounted gantry cranes to handle the increase in container throughput. The project will allow Bayport to handle

¹⁸ METRO's Fiscal Year 2018 is October 1, 2017 through September 30, 2018

more than 2 million 20-foot-equivalent units (TEUs), doubling its present capacity, and will help support international trade with more than 1,000 ports in more than 200 countries. Increased productivity as a result of the expansion is projected to reduce truck waiting and idling times by an estimated 7.6 minutes on average.

CLEANER, MORE-EFFICIENTLY OPERATING CRANES

Port Houston replaced ten (10) Tier-2 755-horsepower rubber-tire gantry cranes (RTGs) at Barbours Cut with eight (8) newer Tier-3 665-horsepower RTGs. These RTGs will operate approximately 2,500 hours a year and will be able to handle the same amount of cargo plus additional cargo as the eight retired cranes because the older cranes averaged about 4 moves an hour while the new cranes average about 12 to 15 moves per hour. The increased efficiency associated with these cleaner, faster cranes reduces the truck idling and associated emissions at the Port.

LYNX AND CONTAINER TRACKING MOBILE APP

Port Houston's online information system that tracks vessel arrivals and container movements at its Barbours Cut and Bayport terminals is called Lynx. The Port has recently expanded access to Lynx to trucking companies and cargo owners so that container availability can be tracked, and the trucking company can be automatically notified when a container is ready for pickup. Additionally, the Port has developed a mobile app that allows drivers to check on the status of a container and its pick up availability. Information on how to access Lynx online and how to access the mobile app can found at: <https://porthouston.com/terminal-toolbox/container-terminals/access-to-shipping-information/>

The expanded access to Port Houston container status at its container terminals through Lynx and the mobile app reduces unwarranted truck trips to the terminals and therefore results in less criteria pollutant emissions.

BAYPORT TERMINAL OPERATIONAL IMPROVEMENTS

The stop sign at the truck exit at the Bayport Container Terminal has been removed and Port Road has been restriped to allow two lanes of truck traffic to exit without stopping. This eliminates idling for all trucks exiting Bayport plus eliminates a source of congestion during peak times.

GATE AUTOMATION

Port Houston has implemented an automated gate system with optical character recognition (OCR) portal to automate equipment identification, traffic processing and damage inspection imaging at the entry gate of the Barbours Cut and Bayport container terminals. The system automatically identifies containers, chassis, and license plates associated with the equipment. Since implementation, gate OCR installation enabled Port Houston to process trucks twice as fast and reduced idling time by 48%, dramatically reducing emissions.

TRUCK PRE-ADVISE PROGRAM

Port Houston is phasing in a Truck Pre-Advise program with the initial phase consisting of a few of the drayage trucking companies that visit the container terminals the most. It will then be expanded to additional drayage trucking companies as the first phase proves to be successful. The Pre-Advise program works by gathering the truck's transaction information in advance (instead of at the gate). The trucking

companies can send their information (Truck License Plate, Chassis Number, Container Number, Booking details, etc.) through Lynx or electronically. Port Houston holds the information and will match it to the truck when it arrives at the terminal. This program will help reduce emissions because there will be a reduction in the time the drivers sit idle at the terminal gates.

PARTNERSHIPS

As part of Port Houston's efforts to exchange older engines with cleaner burning technologies, the Port created public/private partnerships with tenants and stakeholders to implement emission reduction strategies and policies. Port Houston has established a proven track-record in securing state and federal grants for emission reduction benefits for Port and Port tenant and stakeholder engines and equipment.

Through the 2009 American Recovery and Reinvestment Act (ARRA)/Diesel Emission Reduction Act (DERA), the Port and six tenant/stakeholder partners used \$2.8 million in grant funds for the replacement, repower and retrofit of 115 diesel engines used in port activity which will result in lifetime reduction 6 tons of PM_{2.5}. Furthermore, the Port provided \$50,000 in matching dollars as leverage for a \$9 million EPA SmartWay grant to fund the revolving Drayage Loan Program

In 2010 the Port was also awarded a DERA grant of \$1.5 million to cover the incremental costs associated with fuel switching activities for all Maersk vessels calling at the Port's container terminals prior to the EPA's mandated North America Emission Control Area implementation in 2012. The fleet of 26 vessels performed 163 vessel calls and fuel switches which resulted in a decrease in emissions of 32 tons of PM_{2.5}.

In early 2015, the Port was awarded almost \$1.8 million dollars for two different DERA grants that will be used to replace older drayage trucks. The funds from one grant were passed through to H-GAC to fund an expansion to its Houston-Galveston Drayage Truck Program. This grant helped to replace 15 older on-road drayage trucks with newer 2010 model year compliant drayage trucks and is expected to reduce 10.2 tons of PM_{2.5} over the lifetime of the trucks. The funds from the second grant were passed through to two (2) of Port Houston's tenants and helped replace 23 older drayage trucks (12 on-road trucks used only on Port Houston turning basin terminal and 11 on-road terminal tractors used to pick up containers at the Bayport and Barbours Cut terminals) with newer on-road terminal tractors with 2010 model year compliant on-road engines. This grant is expected to reduce 13.8 tons of PM_{2.5} over the life of the trucks.

Regional partners, including the Port, planned to apply for additional DERA funding during the 2016 funding opportunity however were unable to finalize a submitting during this year. However, the Port has applied for, and received, DERA funding in 2017 for Port owned work trucks and buses. It is expected that these projects will result in further 0.43 tons of PM_{2.5} reductions within the region.

BROADWAY DOUBLE TRACK PROJECT

Access to the entire rail network serving the south side of the Houston Ship Channel (HSC) was constrained by a short, but critical bottleneck segment of single track. Port Houston owns the track segment, which is operated by Port Terminal Railroad Association (PTRA). All trains serving the industrial and port facilities on the south side of the HSC had to operate over this 0.28-mile segment of single track, which includes a single-track bridge over Broadway Street. The single-track segment was operating above its original design capacity which was causing 2 1/2 hours of train delay per day. Adding a second track was needed because the additional capacity provided by the second track will be sufficient to handle anticipated volume growth for the next thirty years.

Port Houston was successful in getting this project into the H-GAC Transportation Improvement Program (TIP) and was completed in July 2019. Having two main tracks on this segment will reduce delays to trains awaiting clearance to enter onto the single track, improving the flow of cargoes to and from industrial and port facilities and reducing emissions.

ELECTRIFICATION OF FLEET

Port Houston has expanded the use of battery electric hybrid rubber-tire gantry cranes (RTGs), purchased five battery electric light-duty vehicles, and an electric terminal tractor (also known as a “yard mule”).

RTGs that have been used by Port Houston are powered by diesel engines in the 600 to 700 horsepower range and can operate around 3,000 hours a year. Recently, Port Houston has started to purchase hybrid RTGs that are powered by smaller diesel engines (around 120 horsepower) and batteries. The batteries will allow an RTG to operate around 50 to 60% of the time without the diesel engine running. Currently, there are 13 hybrid RTGs at the Barbours Cut Container Terminal. For the Bayport Container Terminal, nine hybrid RTGs will be delivered by the end of 2020 and nine more will be delivered by the end of 2021.

Port Houston purchased five Chevrolet Bolts at the end of 2019 and were delivered in early 2020. Three of the Bolts are assigned to different Port Houston departments while the remaining two are available for any Port employee to use.

Port Houston has also used TCEQ TERP funds to purchase a battery electric terminal tractor that will be delivered by the end of November 2020 to the Bayport Container terminal. This electric terminal tractor will be used alongside the current fleet of diesel-powered terminal tractors to determine if it meets the operational needs of Port Houston.

PORT OF GALVESTON

GREEN MARINE

In 2019, the Port of Galveston joined Green Marine as part of a long-term commitment to continuous improvement in environmental performance and began working on certification. Green Marine is the leading voluntary environmental program for North America’s maritime industry. The Green Marine environmental certification program addresses 12 performance indicators: greenhouse gases, air emissions, spill prevention, waste management, environmental leadership, and community impacts – some applicable to shipping activities, others to landside operations. The certification process is rigorous, transparent, with results independently verified every two years.

The Port was certified in June of 2021, making it the second Texas port participating in the program. Joining Green Marine helps the Port identify and implement best practices, manage our environmental initiatives, measure our progress and strive for continuous improvement. Equally important, Green Marine encourages collaboration with governments, port tenants and citizen groups in implementing action plans and green initiatives.

RENEWABLE ENERGY

The Port of Galveston is on a five-year plan to transition to 100% green power. Beginning 2021, the Port is working with Tradition Energy to explore cost effective strategies to swap brown energy for green with a phased in approach through 2023. The most recent contract for electricity for the Port secured begins in 2024 and includes 100% green energy. Additionally, the contract includes the purchase of Renewable Energy Credits (RECs) representing 100% of the contract quantity on the Port's behalf and will retire them through the ERCOT REC tracking system. Renewable energy credits representing the contracted usage for the previous calendar year will be retired March 31st of each year until the contract terms are satisfied. In the interim, we will strive to replace brown energy with renewable energy by an additional 20% each year.

SHORE POWER

Some vessel types, such as cruise, container, and refrigeration, can require significant power while at berth. This power is typically generated by diesel auxiliary engines. Vessel emissions running auxiliary diesel engines at berth can be significant contributors to air pollution. Shore power can be used by marine vessels to plug into the local electricity grid and turn off auxiliary engines while at-dock. When using shore power, auxiliary systems such as lighting, air conditioning, and crew berths use energy from the local electrical grid. Shore power typically produces zero onsite emissions. The infrastructure cost is significant and there are many questions to be addressed.

The Port is partnering with Texas A&M University to conduct a cost benefit study for electrifying the piers. This research includes: inventorying vessels calling the port and their specifications; exploring the electrical infrastructure of both the Port as well as transmission networks leading to the port; understanding the Port's 20-year master plan and construction schedule; determining estimated project costs to install shore power infrastructure; partner with CenterPoint Energy to determine challenges and solutions; estimating shore power demand at the Port of Galveston over the next 5-10 years; calculating the cost benefit with and without emissions and health impact assumptions; and finally making recommendations for financing, phasing, and alternative strategies

TERMINAL 14 PROJECT

A public-private partnership between Royal Caribbean International and the Port of Galveston, is moving forward with development of a new cruise ship terminal. The cruise terminal is estimated to cost \$100 million and encompass 150,000 square feet of space. When the project was announced, Royal Caribbean said the new terminal would be large enough to handle Royal Caribbean's largest cruise ships, including an Oasis Class ship or one of the new Icon Class ships. The facility will feature state-of-the-art technology, including mobile check-in and facial recognition to expedite guest arrival. The terminal will be designed and developed sustainably to meet LEED (Leadership in Energy and Environmental) certification standards. Additionally, Royal Caribbean has an interest in having shore power facilities located at this new terminal. A feasibility assessment will be conducted to determine what would be required and how the timing could work when a new terminal opens in late 2022.

PILOT LNG

The Port of Galveston is working with Pilot LNG on the development of an LNG bunker terminal that will be located on Pelican Island. The LNG bunker fuel will serve the greater Galveston / Houston port

complex by supplying clean burning LNG to the rapidly expanding fleet of LNG - fueled vessels. LNG has much lower emissions than conventional marine fuels and emits zero SO_x. LNG has virtually no particulate matter thereby emitting 90% less NO_x vs. conventional HFO. Lastly, LNG as a marine fuel is less costly when compared to low Sulphur fuel oil.

The concept is land-based infrastructure; floating gas liquefaction and storage unit; liquefaction capacity 0.5 Mtpa; storage capacity 18,000 m³; hull permanently moored; electric powered by Renewable Energy sources; bunkering vessel delivers LNG to ships; established gas supply from the Houston Pipeline System Intrastate System (Energy Transfer); located on Pelican Island, ideally situated within the largest port complex in the US. This site allows easy access for all ships calling on the Ports of Galveston, Houston, and Texas City.

ALTERNATIVE FUEL VEHICLES

In line with the Port's values of sustainability, the Port of Galveston is developing a transition strategy to alternative fuel vehicles and equipment. With a vehicle fleet of 47 vehicles and approximately 85 pieces of equipment including cranes, tractors, front end loaders, generators, sweepers, etc., the Port believes a measured approach based on cost benefit analysis is appropriate.

Currently, Port of Galveston is working on the following assessments to determine the sensible approach:

- Conduct a life-cycle cost analysis of alternative-fuel vehicles;
- Evaluate the availability of alternative-fuel vehicles for specific agency needs;
- Evaluate the availability of fueling and maintenance infrastructure;
- Set a goal in a guiding policy decision to reduce polluting GHG emissions and improve air quality

Based on the results, the Port will develop a 10-year replacement plan to incrementally upgrade to alternative-fuel vehicles and low-emission vehicles. The intention of this plan is to use cost-benefit analysis to examine vehicle replacement, taking into account maintenance costs, fuel costs and residual book value, with the goal of purchasing alternative-fuel vehicles where practical and financially feasible.

CONGESTION REDUCTION

Galveston Island is visited by 7 million tourists annually. In combination with a healthy cargo and strong cruise business, this creates significant congestion for the island. As part the Port's 20-year Strategic Master Plan, the Port is creating a 4-lane cargo corridor with a bike path and smart signage to provide an alternative route for trucks and heavy cargo; enhance functionality and efficiency while reducing traffic congestion and positively impacting traffic flow to and from the Port of Galveston's cargo facilities, cruise facilities, surrounding historical district, and nearby downtown business area; ease congestion and passage of residents, visitors, and trucks alike as well as decrease pedestrian and vehicle conflict and congestion using dynamic signage; and add to existing bike trails to allow for greater mobility and safety for those in the area.

COMMUTE SOLUTIONS

The Port of Galveston is also partnering with H-GAC's Commute Solutions Program. Currently, in phase II, the Port is looks forward to well-received opportunities. This Program is designed to develop and implement travel demand management solutions. Alternatives include: promoting shared and

active transportation; lessening peak period congestion; reducing vehicle miles traveled among Port employees in order to improve air quality.

CHARGING STATIONS

The Port is applying under the Texas Volkswagen Environmental Mitigation Program to install electrical vehicle charging stations. There are 39 other charging stations on Galveston Island, and this project would almost double the capacity for electric vehicle charging within the city limits. This project involves placement of 26 electric vehicle charging stations for parking lots A, B, and C, as well as a parking garage for cruise passengers. As a cleaner alternative, electric vehicles are an important step in sustainable transportation.

TEXAS DEPARTMENT OF TRANSPORTATION

CONNECTSMART PROGRAM – ADVANCED TRANSPORTATION TECHNOLOGY DEPLOYMENT

Houston ConnectSmart is a multi-year program with the overarching goal of reducing congestion, optimizing available transportation capacity, and managing demand. ConnectSmart is introducing and deploying an advanced mobility platform, made available to Houston region users through a mobile application that will provide the medium for introducing Active Demand Management (ADM) strategies to further enable the region's Transportation Systems Management & Operations (TSMO) regional goals to be achieved.

ConnectSmart's app will encourage congestion relieving choices by providing users with available multimodal travel choices, predictive travel times, turn-by-turn navigation by mode, parking information, travel costs and mobile payment options, while leveraging behavioral change through Artificial Intelligence. Travel behavior changes would include making a trip at a less congested time by leaving earlier or later (reducing congestion impacts) taking an alternate route, or utilizing alternative modes of travel like public transit, carpooling, vanpooling, and biking (reducing VMT). By providing this information and more in the ConnectSmart app, users can help improve traffic congestion, air quality, safety, efficiency, and system performance within the Houston region and be rewarded for them.

In addition, ConnectSmart will foster agency collaborations, including ongoing integrations with H-GAC's, Houston METRO's, and Houston TranStar's programs, services, and data. Most important, transportation agencies will be provided with multi-sourced data and analytics to better support decision making, demand management, and increase access and connections to employment, education, essential services, among other destinations to provide for greater opportunities.

The Houston ConnectSmart program is built on a strong public-private-professor partnership (P4) with local transportation agencies (e.g., H-GAC, Houston METRO, TranStar, among others) that provide the foundation for a long-term and financially sustainable program.

OPERATIONAL EFFORTS TO REDUCE EMISSIONS

The Texas Department of Transportation (TxDOT) has been working to reduce both NO_x and PM_{2.5} through a variety of different strategies. TxDOT has encouraged contractors in both construction and maintenance

to limit work hours to times which would have the least impact on air quality. For construction contractors in high-volume corridors, this includes limiting construction to nighttime and other off-peak periods. For maintenance contractors, this focuses on curtailing work during ozone action days. In addition, for TxDOT staff is encouraged to limit idling of agency vehicles when possible.

CLEAN AIR PLAN

TxDOT's Clean Air Plan (CAP) is the Department's effort to set an example in the field of air quality. In March 2002, TxDOT partnered with the Texas Commission on Environmental Quality to create the Drive Clean Texas campaign (DCT), the first state-sponsored public awareness program aimed at motivating individuals to change driving habits. DCT asks the public to drive less, to maintain their vehicles so that they pollute less, to avoid unnecessary idling, to buy a vehicle that pollutes less, and to pollute less by driving the speed limit.

The CAP is TxDOT's internal effort to take the same kind of actions that DCT asks of the public. The CAP is far more ambitious, however, including all the measures of DCT and many more. The CAP program asks TxDOT employees voluntarily to participate by logging in their clean air activities during the period from May 1st to September 31st (the ozone season). In return, employees can earn between two to eight hours leave: <http://crossroads.org/env/CAP/CAPsite/Incentives.htm>

However, TxDOT's Clean Air Plan (CAP) campaign for 2020 which would normally begin May 1, 2020 was suspended by TxDOT Transportation Commission due to the COVID-19 pandemic until TxDOT returns to routine operations and Administration approves the extension of the program for another year.

ALTERNATIVE FUEL CORRIDOR SIGNAGE

In compliance with the Federal Highway Administration's (FHWA) Alternative Fuel Corridor, TxDOT is working to install supporting signage along approved alternative fuel corridors. This process is ongoing.

ELECTRIC VEHICLE PILOT

In addition to these efforts, TxDOT has also undertaken a multi-year project to expand the use of alternative fueled vehicles for areas within the so-called TERP Triangle. A roughly triangular region with vertices in Houston, San Antonio, And Dallas-Fort Worth that includes most of the major metropolitan areas in the State of Texas. This program will work to replace older gasoline and diesel vehicles with new, alternative fueled models, including all-electric ones. The first phase of this project is ongoing and will focus on the HGB area and will take place in the biennium that includes 2018 and 2019.

RAILROAD PROJECTS

ANTI-IDLING ENGINE CONTROLS

Approximately 75% of Union Pacific (UP) switcher engines operating in the HGB area have anti-idling controls, which reduce PM emissions. This is an improvement over 60% as reported in the 2016 version of this report.

REFURBISHED SWITCHER AND LOW EMISSION ENGINES

The Port Terminal Railroad Association (PTRA) and UP are operating newly refurbished switcher engines on the Clinton line. UP currently has 51 new low-emission genset¹⁹ engines in the Houston area. In addition, UP has 13 Tier 2 locomotives funded by Texas Emissions Reduction Plan (TERP). At present, there are no Tier 4 locomotives assigned to the Houston region, however it is likely that a number of the vehicles are operating within the Houston region at a given time.

REGULATORY PROJECTS

A number of regulatory projects have reduced fine particulate matter emissions in the HGB region. Some of these initiatives are outlined below.

EPA CONTROL OF EMISSIONS FROM SHIPS

In March 2010, the International Marine Organization (IMO) officially designated waters off North American coasts as an Emission Control Area (ECA) with stringent international emission standards for ships. The first-phase fuel sulfur standard began in 2012, which required that all marine diesel fuels used by ships in the North American ECA be limited to a maximum fuel sulfur content of 10,000 ppm (1 %). In January 2015, a more stringent maximum of 1,000 ppm (0.1 percent) came into force for all ships in the North American ECA. It is anticipated that the implementation of the ECA will reduce PM_{2.5} shipping emissions in the Gulf Coast region by 86%.

FEDERAL MOTOR VEHICLE CONTROL PROGRAM

The Federal Motor Vehicle Control Program has significantly reduced exhaust emissions from both light duty and heavy-duty vehicles in the HGB area.

INDUSTRY PROJECTS

As of January 2011, approximately 90% of the nation's refinery capacity is under lodged or entered 'global' settlements to reduce SO₂ emissions at both refineries and sulfuric acid plants²⁰.

An East Harris County company reduced particulate emissions by an estimated 24 tons per year during 2005 to 2007 with several projects including boiler shutdown, process changes and cooling tower equipment upgrades. Another company upgraded cooling tower equipment and decreased particulate emissions (quantity not estimated).

Shell Deer Park made several equipment upgrades that reduced particulate and/or sulfur dioxide emissions, including the 2003 installation of a wet gas scrubber on refinery's cat cracker, resulting in the reduction of 61 tpy of PM and 4,674 tpy of SO₂ ²¹. Shell also installed a flare gas recovery compressor system

¹⁹ Genset locomotives are powered by ultra-low-emission diesel engines that are connected to electric generators, thus the name "Generator-Set," or "Genset" switcher. http://www.tceq.texas.gov/assets/public/implementation/air/sip/hgb/hgb_mveb_2012/12002SIP_ado_complete.pdf

²⁰ <http://www2.epa.gov/sites/production/files/documents/refineryinitiative-powerpoint021111.pdf>

²¹ Based on comparison of 2002/2003 emissions to 2004/2005 emissions

on the Deer Park Refinery's East Property Flare at end of 2012—resulting in the reduction of 2475 tons of SO₂²² annually.

Valero Refining has implemented control measures to reduce SO₂ emissions by 3,500 tpy. The Rhodia sulfuric acid plant was projected to decrease its SO₂ emissions by 8,984 tons per year from 2005 to 2012.

The Dow Chemical Company completed several shutdowns and upgrades to facilities at Freeport and Deer Park that reduced PM emissions by 192.97 tpy. These projects include: a shutdown of the Acetylene plant (Deer Park), 2008; Latex plant shutdown (Freeport), 2009; Upgrades to the Dow Pyridine derivatives facility and cooling tower (Freeport), 2009; Power 3, Power 6 and Poly 2 facilities shutdown (Freeport), 2010; EDC VCM facility shutdown (Freeport), 2011; Styrene 1, 2, EBA and distribution facilities shutdown (Freeport), 2012; and improvements to HT cooling Tower in Deer Park, including drift eliminators, 2013.

ENERGY EFFICIENCY IN THE HOUSTON-GALVESTON-BRAZORIA REGION

In 1999, the Public Utility Commission of Texas (PUCT) adopted rules for the state's Renewable Energy Mandate, establishing a renewable portfolio standard (RPS), a renewable-energy credit (REC) trading program, and renewable-energy purchase requirements for competitive retailers in Texas²³.

The State has established the Texas Energy Efficiency resource goal of 20% incremental load growth in 2011, which is equivalent to approximately 0.10% annual savings, with 25% in 2012, 30% in 2013 and onward²⁴.

In Fort Bend County, NRG Energy added a 75-megawatt natural gas generating unit to its W.A. Parish power plant. This natural gas unit has higher energy efficiency and less PM_{2.5} emissions than a conventional power plant.

Port Houston also increased its renewable energy purchases from 25% to 30%.

POTENTIAL AND FUTURE PROJECTS

These ideas are NOT commitments of future action. They are merely ideas, and their implementation would be contingent on funding availability, and an affirmative commitment from the proposing agency. All ideas are voluntary and would result in PM benefits.

H-GAC CLEAN VEHICLES & CLEAN SCHOOL BUS PROGRAMS

The Clean Vehicles Program will continue to provide significant emission reductions within our region. This program has funded replacements of school buses, private fleets, drayage trucks, transit vehicles and more. Since its start, the program has provided more than \$78 million in financial aid, replaced more than 2,700 engines and developed several alternative fueling stations. In the future, the Clean Vehicles Program

²² Based on comparison of 2011 emissions versus 2013 preliminary-AEI emissions

²³ http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=TX03R&re=1&ee=1

²⁴ <http://www.aceee.org/sector/state-policy/texas>

will target heavy-duty fleet replacements which will continue to result in both PM and NO_x emission reductions for the region.

In 2015, EPA awarded a total of \$240,000 to three school districts in Texas to replace older diesel school buses with new buses that emit 90 percent cleaner emissions²⁵. The Aldine Independent, Lone Star Public School and Spring Branch Independent School Districts will receive rebates through EPA's Diesel Emissions Reduction Act to replace 12 of their existing diesel school buses. Since 2008, the DERA program has funded more than 600 clean diesel projects across the country. These projects have reduced emissions for more than 60,000 engines. Over 500 school bus fleets applied to EPA's Rebate Program, requesting more than \$32 million in funding.

DEPARTMENT OF ENERGY ZERO-EMISSION DELIVERY VEHICLE DEMONSTRATION PROJECT

The goal of H-GAC's Zero Emission Truck project is to demonstrate the effectiveness of all-electric delivery vehicles in the Houston region. H-GAC received more than \$2 million from the U.S. Department of Energy for this project. H-GAC has partnered with United Parcel Service (UPS) and Workhorse to develop, assemble, and deploy all-electric delivery vehicles along with an electric vehicle charging station (EVSE) for each vehicle at facilities within the HGB region. This has resulted in the deployment of 18 of these all-electric vehicles on regional roads. These vehicles will be tested over two years to measure emission reductions and evaluate vehicle performance. It is anticipated that an additional 12 vehicles will be deployed with local fleets before completion of the project. By deploying zero emission trucks, the project will reduce petroleum consumption and emissions of harmful air pollutants, including PM.

REGIONAL TEXAS EMISSION REDUCTION PROGRAM

H-GAC received \$3 million from TCEQ to establish the second Regional Texas Emission Reduction Program (TERP). The Regional TERP provided grants to local governments for the replacement of non-road equipment and on-road vehicles powered by heavy duty diesel engines, and aids in the replacement of drayage trucks associated with the Drayage Loan Program. Regional TERP grant amounts are based upon the NO_x reduction created by the equipment and vehicle replacement. These replacements will also result in PM_{2.5} reductions in the HGB area.

EXPANSION OF MASS EMISSIONS CAP AND TRADE PROGRAM

In Texas, the Mass Emissions Cap and Trade Program (MECT) is a market-based cap and trade program that implements an annual NO_x emissions cap for major source facilities within the Houston-Galveston-Brazoria ozone nonattainment area. H-GAC and other local stakeholders including ExxonMobil, Environmental Defense Fund, and others have been working with TCEQ to expand the existing MECT program to allow the inclusion of exhaust capture systems and emissions treatment systems for oceangoing vessels and locomotives as eligible candidates for the cap and trade program. At present, these facilities are not eligible to participate in the program. It is anticipated that, should they become part of the program, that they will help to encourage the introduction and expansion of these control measures within the region.

²⁵ <http://www.epa.gov/cleandiesel/dera-rebate-schoolbus.htm>

VOLKSWAGEN SETTLEMENT / ELECTRIFY AMERICA

H-GAC has been working to ensure that the HGB region is included in all aspects of the recent settlement between Volkswagen and EPA. Actions taken using Settlement funds are earmarked to remediate increased concentrations of NO_x resulting from fraudulent diesel emissions controls, however any resulting air quality improvements should also result in reduced PM_{2.5} concentrations. To this end, H-GAC has worked with Electrify America to implement the zero-emissions vehicle investment portion of the Settlement as well as justify the deployment of electric vehicle charging equipment within the region. As a result, the HGB region was chosen as one of the focus areas for the first Electrify America investment cycle. H-GAC has also been working with TCEQ, the state beneficiary for the Settlement, to offer recommendations regarding the most efficient and cost-effective methods for capturing emission reductions using Settlement funds.

HOUSTON INDEPENDENT SCHOOL DISTRICT ELECTRIC SCHOOL BUS DEMONSTRATION PROJECT

This potential future project is being led by National Strategies LLC as part of a commitment made under the Clinton Global Initiative (CGI), with the support of Houston Independent School District (HISD), TransPower and NRG and others. The demonstration project being considered includes the repower of 4 conventional type-C HISD school buses to all-electric, battery powered vehicles (EV) with vehicle-to-grid (V2G) technology and vehicle-to-building (V2B) capability. The project duration is anticipated to be 2.5 to 3 years, including a 9-month bus operation cycle in summer and winter seasons with a total cost of approximately \$2 million. The overall objectives of the project are to demonstrate the economic viability and air quality benefits of EV V2G school buses in order to speed the adoption of zero-emission school buses and associated emission reductions across the U.S.

CITY OF HOUSTON RENEWABLE ENERGY

In 2014, EPA recognized the City of Houston for its use of green power practices and technologies²⁶. Houston signed a two-year agreement to purchase more than 620 million kilowatt-hours of certified renewable energy certificates from wind projects. This purchase accounts for half of the city's municipal power needs and make Houston the largest municipal purchaser of renewable power in the Green Power Partnership. The City is planning to continue to expand this renewable energy portfolio through the construction of 30 MW of solar power which will be used to power City facilities.

PORT HOUSTON FUTURE DUST SUPPRESSION PROJECTS

Fugitive road dust entrainment rates, whether from parking lots or on the transit network, depend upon the dust loading, vehicle speed and number of vehicles. Dust loading has been controlled by paving unpaved surfaces and regular pavement cleaning or watering or other treatment of unpaved surfaces. The benefits of these programs are proportional to the activity on those surfaces. Analysis of these projects is relatively straightforward given the level of activity and understanding of the dust loading of those areas.

Port Houston is planning dust suppression projects in future years. Approximately 30 acres will continue to have emulsified asphalt sprayed following this initial effort.

²⁶ <http://www.epa.gov/greenpower/awards/winners.htm>

PORT HOUSTON AUTHORITY BARBOURS CUT TERMINAL GATE REDESIGN AND EXPANSION

Port Houston plans to redesign and expand the truck entrance and exit gates at the Barbours Cut Terminal. The new design and expansion will increase gate capacity which will handle the anticipated future throughput. This project will also look state-of-the-art gate processes, operating systems, practices, and technology, which have changed significantly since the gate was constructed in the late 1990’s

OVERWEIGHT CONTAINER ROUTE BETWEEN HGB REGION PORTS

An overweight or dedicated truck route can improve emissions by reducing stop-and-go emissions and reducing the number of truck trips. During the most recent rulemaking session, the Texas legislature passed a rule that allows shipping companies to purchase permits that allow overweight trucks on regional roads. These rules may allow more cargo to be shipped with fewer trucks as well as help to smooth traffic flow around Port areas which can result in improved emissions. In other transportation measures, such as traffic signal improvements, traffic flow improvements have been shown to reduce emissions rates by five (5) to ten (10) percent for regional fleets. The relative benefit may be higher with heavy-duty trucks than for light-duty vehicles because braking, idling, and acceleration are high emissions modes for trucks.

Overall emission reductions will also depend on the dedicated truck routes and the expected usage of routes. Other considerations include whether infrastructure costs are incurred to allow overweight trucks, create grade separation, or overcome obstacles to allow such trucks routes to be constructed.

REPLACEMENT OF RAILROAD SWITCHER ENGINES

In the Houston area, there has been discussion regarding a potential future railroad demonstration project involving the replacement of traditional switcher engines with natural-gas-powered engines. Powering long-haul locomotives with LNG would result in PM reduction benefits for the HGB region.

TIER-3 MOTOR VEHICLE FUEL AND EMISSION STANDARDS

The Tier-3 emission standards include a lower PM emission standard for light-duty gasoline vehicles beginning in 2017 and phasing in through 2025. This means that in addition to the 2007 PM standards for heavy-duty diesel that is reducing PM emissions in the near term, as the fleet turns over, on-road vehicle PM emissions will continue to decrease in the future. The table below shows the effect of Tier-3 emission standards in years 2018 and 2030.

Comparison of Emission Reductions from On-Road Inventories ²⁷
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²⁷ <http://www.epa.gov/otaq/tier3.htm>

	2018		2030	
Pollutant	National Inventory Reduction	Air Quality Inventory Reduction	National Inventory Reduction	Air Quality Inventory Reduction
PM _{2.5}	-0.1%	-0.4%	-10.0%	-10.4%
NO _x	-9.6%	-9.9%	-24.6%	-25.5%
VOC	-2.8%	-2.4%	-15.5%	-14.4%
CO	-1.6%	-1.6%	-23.4%	-25.3%
SO ₂	-56.3%	-55.9%	-55.7%	-55.0%

CONCLUSION

H-GAC's participation in PM Advance has been, and continues to be, a successful example of voluntary collaboration between local government, business, industry, citizens, and environmental groups in our region. In the past, the HGB region has faced potential nonattainment designations for PM. Since that time, our region has made significant improvements and successfully avoided nonattainment status in 2015.

This Path Forward document continues a framework for the region to continue to meet air quality standards and achieve the Program mission to encourage voluntary accelerated implementation of current clean air strategies and programs. Our region needs to continue to collectively work together to better understand PM. Future growth will inevitably impact particulate matter emissions in our region—whether due to population, industry or economic growth. Through this program, we will continue to work together to understand regional PM emissions and meet our air quality and attainment goals.