Quarterly Report of Air Quality Monitoring January 1, 2021 to March 31, 2021 at the Gregory – Portland Community Air Monitoring Stations

Prepared by

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April 21, 2021

Contents

Executive Summary

There are three air monitoring stations in the Gregory-Portland area in operation. The Gregory Fresnos Community Air Monitoring Station on Fresnos St. began continuous monitoring operations October 1, 2019. Two additional air-monitoring stations in Portland, TX near the intersection of Buddy Ganem Dr. and Wildcat Dr. on the campus of the Gregory-Portland High School and on Broadway Blvd. on the campus of the old East Cliff Elementary School began operations on January 1, 2020.

A large-scale slowdown in the world economy owing to the COVID 19 pandemic has been underway since early 2020, but this has had minimal impact on air monitoring operations. The instruments in the stations operate automatically and can be accessed remotely. Station operators are locally based and need only travel a short distance to conduct standard operations and maintenance. The University of Texas at Austin (UT Austin) personnel have been working from home with no loss of effectiveness.

In mid-February 2021, a significant cold weather event in Texas and much of America led to a suspension of operations at all three sites for a few days.

The public website developed as the community's source for information about the community air monitors continues to provide information about air quality and monitoring data from the three air monitoring stations (https://gpair.ceer.utexas.edu).

Since monitoring began, some measured pollutant concentrations have exceeded the concentration levels of National Ambient Air Quality Standards (NAAQS); however, these values have not been sustained long enough or measured frequently enough to violate a NAAQS. Furthermore, measured hydrocarbon concentrations have not exceeded the levels of concern published by the Texas Commission on Environmental Quality (TCEQ).

UT Austin would be happy to answer any questions or conduct additional analysis at the community's or sponsors' requests. Contact Vincent Torres at vmtorres@mail.utexas.edu for information on the website or Dave Sullivan at sullivan231@mail.utexas.edu with questions about the monitoring data and analyses in this report.

1.0 Introduction

This report is jointly funded by Cheniere Energy and Gulf Coast Growth Ventures (GCGV) as part of their separate community air-monitoring programs. This report includes reviews and analyses conducted by The University of Texas at Austin (UT) of the air monitoring data obtained at the three stations since their continuous monitoring operations began. UT established the Gregory Fresnos (GF) station for Cheniere Energy and has managed the station since continuous monitoring operations began on October 1, 2019. AECOM, an engineering company, established the Portland Buddy Ganem (PBG) and Portland Broadway (PBway) stations for GCGV and has managed the stations since continuous monitoring operations began on January 1, 2020.

2.0 Summary of Activities January 1, 2021 through March 31, 2021

The international COVID 19 pandemic has caused a large-scale slowdown in a wide range of activities since March 2020. While this has had no impact on air monitoring operations, it may have had some effect on activities in the community, which could have effects on air quality. As was recorded in the last quarterly report, across Texas, the TCEQ recorded significantly fewer ozone exceedance days in 2020 compared to recent years, and hydrocarbon concentrations in nearby Corpus Christi measured at the TCEQ Palm station in the Hillcrest neighborhood were generally lower in average concentrations from April through December 2020 as compared with April through December 2019. Year-to-year differences can be caused by combinations of human activity and weather. However, as was reported in the previous quarter, published research has appeared that suggests lower pollution concentrations in many parts of the world in 2020 was owing to reduced emissions associated with activity changes brought on by responses to the pandemic[1].

Periodically each year, there will be a few days when data will be missing due to annual equipment maintenance. Such was the case for the Portland Broadway (PBway) station on January 18 - 21, 2021 and the Portland Buddy Ganem (PBG) station on February 22 - 25, 2021.

In mid-February 2021, a significant cold weather event in Texas and much of America led to a suspension of operations and reporting of data at all three sites for a few days as follows.

- The Portland Buddy Ganem (PBG) station auto-GC: February 15 – 19.
- The Portland Broadway (PBway) station auto-GC: February 15 - 19.
- The Gregory Fresnos (GF) station auto-GC: February 15 - 18.

There have not been any long-term problems found with monitoring equipment associated with this cold weather event.

The public website developed as the community's source for information about the community air monitors continues to provide information about air quality and monitoring data from the three air monitoring stations (https://gpair.ceer.utexas.edu).

This report focuses on the data collected at the three air monitoring stations during the period

[1] See https://cen.acs.org/environment/atmospheric-chemistry/COVID-19-lockdowns-had-strange-effects-on-air-pollution-across-the-globe/98/i37
https://www.nature.com/articles/s41893-020-0581-y
https://www.sciencedirect.com/science/article/pii/S0048969720350506

January 1 through March 31, 2021.

3.0 Air Monitoring Station Locations & Information

Currently, there are three air monitoring stations in the Gregory-Portland area in operation, one station operated by UT in Gregory, TX and two operated by AECOM in Portland, TX.

The locations of the three stations and parameters measured are summarized in Table 1. The locations of the three stations are shown in satellite view in Figure 1. Also shown in Figure 1 are the locations of the Cheniere liquefied natural gas facility under expansion and the under-construction GCGV ethane-cracker facility. Note that Figure 1 has been updated from earlier project reports to reflect updated aerial imagery at the Cheniere facility and at the GCGV facility.

Table 1. Gregory-Portland Community Air Monitoring Stations and Parameters Measured

Air Monitoring Station Name & Address	Volatile Organic Compounds (VOCs) 46 compounds	Ethylene oxide (EO) 24 hr canister every 6th day	Nitrogen Oxides (NOx, NO, & NO2)	Sulfur Dioxide (SO_2)	Particulate Matter (PM) Mass, particles < 2.5 micron diameter	Wind Speed (WS), Wind Direction (WD), Ambient Temperature (T), Relative Humidity (RH), & Barometric Pressure (BP)
Gregory Fresnos Stephen Austin Elementary 401 Fresnos St. Gregory, TX	Yes	No	Yes	Yes	Yes	Yes
Portland Buddy Ganem 307 Buddy Ganem St. GP High School Portland, TX	Yes	Yes	No	No	Yes	Yes.+ precipitation
Portland Broadway 175 Broadway Blvd. Old East Cliff Elementary School Portland, TX	Yes	Yes	No	No	Yes	Only WS, WD

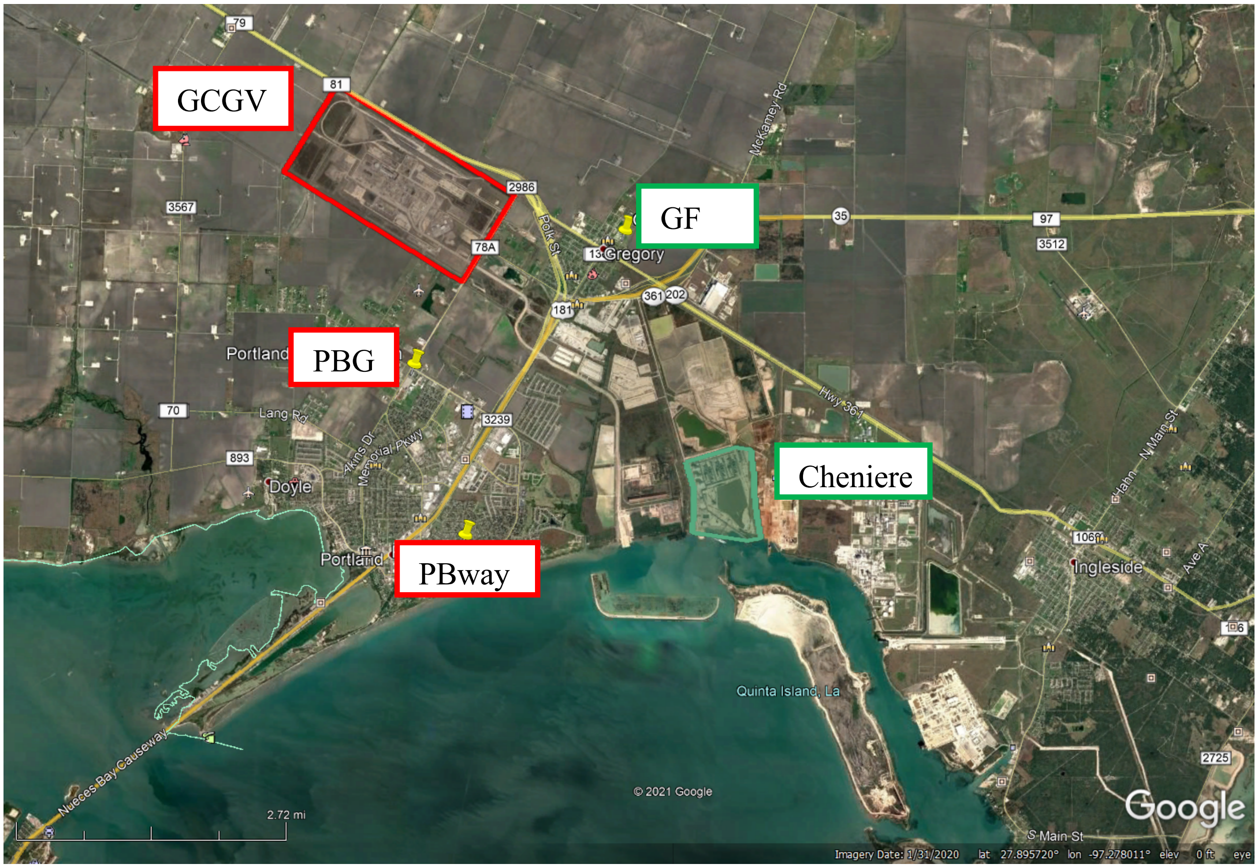

Figure 1. Location of Gregory-Fresnos Community Air Monitoring Station (GF), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG) and on Broadway (PBway) and the Cheniere Energy and GCGV industrial facilities

4.0 Summary of Measurement Data

As described in each report, the reader is reminded that pollutant concentrations are affected by several factors. One, of course, is the emission of a gas or smoke from a source or the availability of dust to become airborne. Another is the weather. Regarding weather, rain can reduce concentrations of several pollutants, especially particulate matter. The "mixing height" is the lower level of the atmosphere wherein gases and particles mix vertically. Temperature inversions such as those experienced at night have low mixing heights and can lead to air pollutants emitted near the surface being trapped at lower altitudes, thus allowing concentrations to increase. The converse is midday periods when the mixing height of the lower atmosphere rises and air pollutants are diluted in a larger volume of air. The wind plays a significant role in moving air pollutants from a source to other locations. For this reason, a large majority of air monitoring stations operated by the TCEQ and all three Gregory-Portland stations measure wind speed and direction. Under high wind speeds, many gas pollutants are dispersed and diluted; however, under high-speed winds, dust on the surface can be picked up and transported, leading to higher particulate concentrations. Higher speed winds passing over the roof of a storage tank can lower the atmospheric pressure on that roof, leading to vapors being drawn out of the tank and into the air. Winds can be thought of as being local – near the surface – and regional – at higher altitudes.

The local wind direction affects pollutant concentrations in terms of whether or not a pollution source is in the upwind direction, or along the local upwind path of the air if wind directions are changing. Similarly, but on a larger scale, the regional wind direction affects pollutant concentrations in terms of whether or not a source such as another major city, a large power plant, a forest fire, etc., is along the regional upwind path of the air. In the graphs that follow, some short-term concentration measurements are significantly higher than the balance of the data. In some cases, this is likely the combination of emission and meteorological (Met) factors, and in other cases, normal emissions can result in unusually high concentrations owing to a source being nearby under low wind speeds or air stagnation.

Please note that the measurement data in this report are quality assured station data made available at different submission frequencies: NOx, NO, & NO_2, SO_2, PM2.5 & Met measurements – weekly; auto-GC VOC measurements – within 90 days of the measurement; and EO canister data – within 60 days of the date the sample was collected. Although all of these measurements, except EO, are made in near-real time, the nature of the complexity in quality assuring the 46 auto-GC target hydrocarbons among the thousands of different organic compounds that exist in the air leads to a lengthy delay in releasing the quality assured target species data. Air samples for EO data are collected at the station and then sent to a laboratory where EO concentrations are then derived upon analysis of the air samples. Hence, the data available at the time this report was written will not all have the same date ranges. For this report, auto-GC and EO data were available through January 31, 2021 and all other data were available through March 28, 2021.

4.1 Gregory Fresnos Station Hydrocarbon Data

Figure 2 shows the time series for hourly concentrations of benzene at the Gregory-Fresnos (GF) station. The figure shows benzene hourly average concentrations for each hour from January 1, 2020 through January 31, 2021 (13 months of data). Benzene concentrations in the air can be of health concern but to date their concentrations have been much lower than TCEQ Air Monitoring Comparison Values (AMCV) of 1,080 ppbC for a single one-hour value or 8.4 ppbC for an annual average concentration. Other AMCVs for auto-GC hydrocarbons can be found at https://www.tceq.texas.gov/cgi-bin/compliance/monops/agc_amcvs.pl (accessed April 2021). Note that a straight line or a gap in a time series graph represents missing data. Data may be missing owing to equipment failure, planned equipment or site maintenance, or external factors such as power loss or severe weather. The maximum one-hour concentration since January 2020 is indicated in the time series graph.

Table 2 lists all target hydrocarbon species measured and reported by the GF auto-GC, with the peak one-hour concentration, maximum 24-hour day concentration, and 2020 annual average concentration for each species. Note that the total sum of the target species (TNMTC) and the total sum of the hydrocarbons (target species plus non-target species and unknown species) (TNMHC) are included in the table. Time series graphs of other hydrocarbon species are also available upon request and any graphs can be made with time-scale (x-axis) or concentration-scale (y-axis) adjustments. Also, concentrations can be averaged by day, month, or other time period upon request. To make a request, contact Dr. Dave Sullivan at sullivan231@mail.utexas.edu or 512-471-7805.

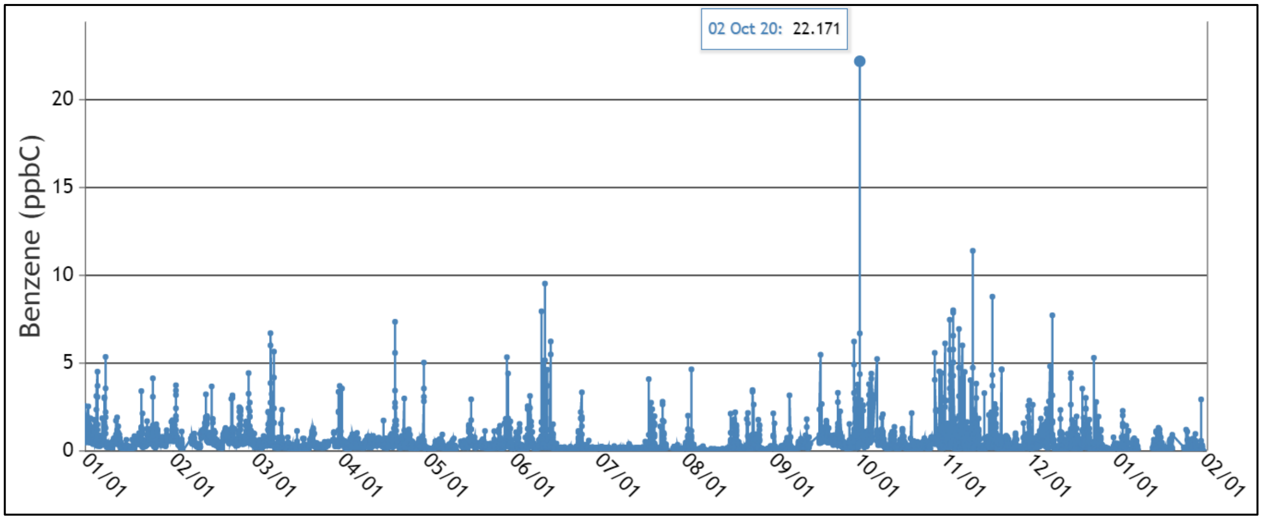

Figure 2. Hourly benzene concentrations at GF station, Jan. 1, 2020 – Jan. 31, 2021, ppbC units

Table 2. Gregory-Fresnos Auto-GC statistics for 2020 (through Dec. 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMTC	7,140	2,316.50	289.24	58.89
TNMHC	7,216	2,259.30	279.22	51.14
Ethane	7,413	767.82	84.19	13.84
Ethylene	7,413	19.13	4.39	0.77
Propane	7,413	564.20	67.22	11.04
Propylene	7,253	21.43	3.83	0.63
Isobutane	7,342	361.32	36.16	4.37
n-Butane	7,339	223.61	37.69	6.55
Acetylene	6,443	11.68	1.45	0.38
trans-2-Butene	7,275	4.20	0.47	0.10
1-Butene	7,342	3.54	0.56	0.23
cis-2-Butene	7,300	1.72	0.28	0.06
Cyclopentane	7,341	5.91	1.06	0.19
Isopentane	7,341	136.60	19.26	3.34
n-Pentane	7,271	403.64	81.91	3.93
1,3-Butadiene	7,396	3.52	0.39	0.07
trans-2-Pentene	7,396	2.25	0.33	0.04
1-Pentene	7,313	67.35	3.11	0.08
cis-2-Pentene	7,396	0.98	0.27	0.02
2,2-Dimethylbutane	6,555	19.16	1.75	0.18
Isoprene	7,205	2.99	0.75	0.10
n-Hexane	7,358	38.82	5.89	1.02
Methylcyclopentane	7,385	18.63	3.28	0.45
2,4-Dimethylpentane	7,374	4.21	0.90	0.04
Benzene	7,386	22.17	2.30	0.45
Cyclohexane	7,385	26.32	4.91	0.51
2-Methylhexane	7,385	8.22	1.45	0.14
2,3-Dimethylpentane	7,373	6.20	0.99	0.07
3-Methylhexane	7,386	10.93	1.65	0.20
2,2,4-Trimethylpentane	7,376	8.36	1.53	0.24
n-Heptane	7,382	16.79	2.64	0.32
Methylcyclohexane	7,365	30.42	5.24	0.56
2,3,4-Trimethylpentane	7,386	2.28	0.28	0.03
Toluene	7,386	18.60	2.56	0.55
2-Methylheptane	7,377	5.03	0.57	0.07
3-Methylheptane	7,385	2.72	0.50	0.06
n-Octane	7,375	9.34	1.31	0.17
Ethyl Benzene	7,386	1.89	0.33	0.06
p-Xylene + m-Xylene	7,386	8.57	1.34	0.32
Styrene	7,216	1.44	0.25	0.02
o-Xylene	7,108	2.65	0.46	0.08
n-Nonane	7,385	3.00	0.64	0.08
Isopropyl Benzene - Cumene	7,373	1.80	0.20	0.01
n-Propylbenzene	7,384	1.43	0.45	0.05
1,3,5-Trimethylbenzene	6,983	0.97	0.16	0.02
1,2,4-Trimethylbenzene	6,815	3.50	0.70	0.16
n-Decane	6,988	4.15	0.56	0.17
1,2,3-Trimethylbenzene	6,396	5.00	1.26	0.13

4.2 Portland Buddy Ganem & Portland Broadway Stations Hydrocarbon Data

Figure 3 shows the time series for hourly concentrations of benzene at the Portland Buddy Ganem (PBG) station, and Figure 4 shows the time series for the hourly concentrations of benzene at the Portland Broadway (PBway) station. Both figures show benzene hourly average concentrations for each hour from January 1, 2020 through January 31, 2021. The maximum hour one-hour concentration to date is indicated in both time series graphs.

As was the case at the Gregory Fresnos station, hydrocarbon concentrations to date are much lower than TCEQ AMCVs or ESLs. Table 3 lists the target hydrocarbon species measured and reported by the Portland Buddy Ganem (PBG) auto-GC and Table 4 lists the target hydrocarbon species measured and reported by the Portland Broadway (PBway) auto-GC with the peak one-hour concentration, maximum 24-hour day concentration, and annual average concentration for each species for calendar year 2020. Time series graphs of other hydrocarbon species are also available upon request, and any graphs can be made with timescale (x-axis) or concentration-scale (y-axis) adjustments. In addition, concentrations can be averaged by day, week, or month upon request. The PBG station only reported Isoprene for one quarter of the year, so an annual average is not provided. Neither station reports 1,2,3-Trimethylbenzene.

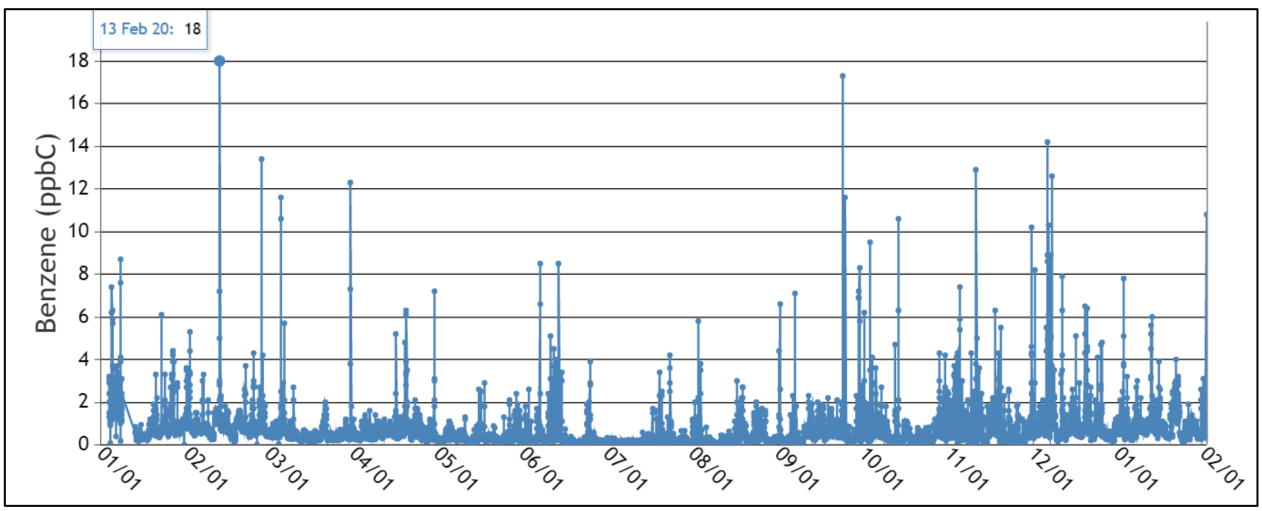

Figure 3. Hourly benzene concentrations at PBG station, Jan. 1, 2020 – Jan. 31, 2021, ppbC units

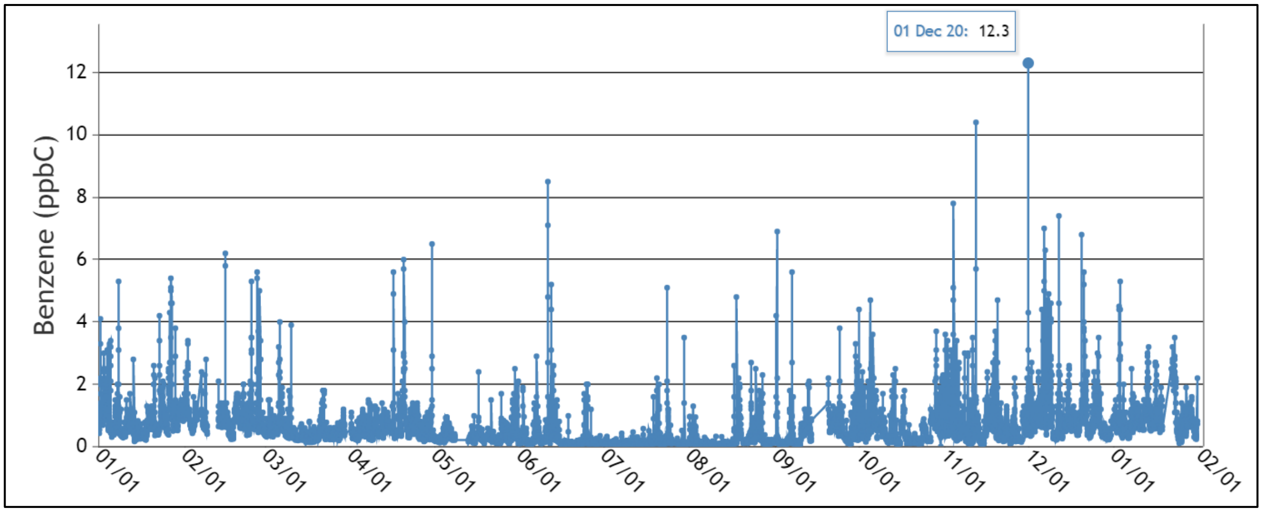

Figure 4. Hourly benzene concentrations at PBway station, Jan. 1, 2020 – Jan. 31, 2021, ppbC units

Table 3. PBG Auto-GC statistics for 2020 (through Dec. 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMTC	7,588	1,960.73	281.96	62.90
TNMHC	7,588	1,867.21	265.83	53.71
Ethane	7,669	603.00	79.15	14.22
Ethylene	7,669	18.50	4.96	0.84
Propane	7,669	441.00	71.72	12.37
Propylene	7,669	19.70	3.40	0.59
Isobutane	7,669	260.00	32.05	4.36
n-Butane	7,669	209.00	44.45	6.87
Acetylene	7,669	9.20	1.30	0.52
trans-2-Butene	7,399	2.20	0.22	0.06
1-Butene	7,667	4.50	0.98	0.29
cis-2-Butene	7,461	4.30	1.79	0.08
Cyclopentane	7,669	5.60	1.06	0.18
Isopentane	7,669	101.00	17.23	3.52
n-Pentane	7,669	83.20	14.99	2.47
1,3-Butadiene	7,669	2.30	1.16	0.06
trans-2-Pentene	7,669	2.00	0.14	0.02
1-Pentene	7,667	4.20	0.35	0.07
cis-2-Pentene	7,666	2.20	0.15	0.01
2,2-Dimethylbutane	7,669	4.30	0.63	0.14
Isoprene	1,957	2.40	0.83	*See Sec. 4.2*
n-Hexane	7,669	31.50	4.87	0.91
Methylcyclopentane	7,668	14.50	2.93	0.59
2,4-Dimethylpentane	7,668	8.00	0.73	0.07
Benzene	7,504	18.00	2.94	0.66
Cyclohexane	7,668	28.50	3.57	0.59
2-Methylhexane	7,669	10.30	1.14	0.19
2,3-Dimethylpentane	7,669	6.70	0.97	0.12
3-Methylhexane	7,669	12.50	1.53	0.31
2,2,4-Trimethylpentane	7,669	13.40	1.39	0.33
n-Heptane	7,669	24.10	3.19	0.43
Methylcyclohexane	7,669	36.60	4.12	0.70
2,3,4-Trimethylpentane	7,669	4.70	0.33	0.06
Toluene	7,669	31.00	3.15	0.70
2-Methylheptane	7,669	5.10	0.93	0.10
3-Methylheptane	7,669	5.50	0.62	0.08
n-Octane	7,669	27.50	2.44	0.22
Ethyl Benzene	7,669	6.40	0.65	0.09
p-Xylene + m-Xylene	7,669	21.30	1.39	0.32
Styrene	7,669	2.70	0.18	0.02
o-Xylene	7,669	7.50	0.59	0.07
n-Nonane	7,669	86.60	4.45	0.11
Isopropyl Benzene - Cumene	7,669	3.80	0.20	0.01
n-Propylbenzene	7,669	17.90	0.92	0.02
1,3,5-Trimethylbenzene	7,483	8.60	0.46	0.03
1,2,4-Trimethylbenzene	7,483	71.00	3.73	0.09
n-Decane	7,481	218.00	11.56	0.38
1,2,3-Trimethylbenzene	Species not analyzed			

Table 4. PBway Auto-GC statistics for 2020 (through Dec. 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMTC	7,295	1,521.20	275.83	59.75
TNMHC	7,295	1,401.20	261.69	53.35
Ethane	7,251	358.00	72.24	15.26
Ethylene	7,251	22.50	5.05	0.92
Propane	7,206	285.00	66.18	10.64
Propylene	7,215	12.80	2.81	1.29
Isobutane	7,251	306.00	26.72	3.72
n-Butane	7,251	216.00	41.55	6.50
Acetylene	7,049	4.10	1.63	0.61
trans-2-Butene	7,236	3.30	0.64	0.18
1-Butene	7,251	71.70	6.56	0.39
cis-2-Butene	7,249	0.80	0.26	0.07
Cyclopentane	7,251	15.20	1.19	0.19
Isopentane	7,251	95.50	16.77	3.32
n-Pentane	7,251	79.00	15.29	2.51
1,3-Butadiene	7,251	14.20	0.74	0.08
trans-2-Pentene	7,251	4.10	0.45	0.04
1-Pentene	7,250	6.80	0.69	0.08
cis-2-Pentene	7,247	4.40	0.91	0.02
2,2-Dimethylbutane	7,251	4.90	0.65	0.13
Isoprene	6,589	8.20	2.23	0.60
n-Hexane	7,251	22.70	4.91	1.00
Methylcyclopentane	7,251	46.50	3.66	0.46
2,4-Dimethylpentane	7,251	4.80	0.45	0.03
Benzene	7,251	12.30	2.22	0.61
Cyclohexane	7,251	18.20	3.06	0.44
2-Methylhexane	7,251	26.40	2.24	0.21
2,3-Dimethylpentane	7,251	13.10	1.13	0.09
3-Methylhexane	7,251	37.00	3.11	0.30
2,2,4-Trimethylpentane	7,251	32.00	3.26	0.48
n-Heptane	7,251	16.30	2.11	0.37
Methylcyclohexane	7,251	22.50	3.57	0.47
2,3,4-Trimethylpentane	7,251	10.30	0.97	0.06
Toluene	7,251	72.20	7.97	0.79
2-Methylheptane	7,251	5.10	0.89	0.09
3-Methylheptane	7,250	3.80	0.81	0.08
n-Octane	7,251	14.10	1.55	0.18
Ethyl Benzene	7,249	6.70	1.06	0.11
p-Xylene + m-Xylene	7,251	24.70	4.14	0.39
Styrene	7,251	0.94	0.18	0.02
o-Xylene	7,251	5.30	0.93	0.08
n-Nonane	7,251	8.10	0.84	0.08
Isopropyl Benzene - Cumene	7,251	1.90	0.13	0.01
n-Propylbenzene	7,251	2.50	0.22	0.02
1,3,5-Trimethylbenzene	7,138	3.80	0.46	0.03
1,2,4-Trimethylbenzene	7,138	10.20	1.19	0.09
n-Decane	7,138	6.00	1.25	0.37
1,2,3-Trimethylbenzene	Species not analyzed			

4.4 Gregory Fresnos Station Criteria Pollutant Data

Sulfur dioxide (SO_2), fine particulate matter (PM2.5), and nitrogen dioxide (NO_2) are three pollutants measured at the GF site that are regulated by the U.S. Environmental Protection Agency (EPA). Some National Ambient Air Quality Standards (NAAQS) are based on annual average concentrations, and some are based on the frequency with which very high concentrations are measured. The rationale is that different pollutants affect human health in different ways.

- PM2.5 has both an annual average NAAQS and 24-hour NAAQS. For the PM2.5 24-hour NAAQS, the three-year average of the 98^{th} percentile 24-hour (midnight to midnight) concentration each year must be less than 35 micrograms per cubic meter ($\mu g/m^3$). The annual average, calculated by first averaging 24-hour averages by quarter and then averaging the four quarters, must be less than 12 $\mu g/m^3$.
- The NAAQS for NO_2 is for the values to average less than 53 ppb in a calendar year and for the 98^{th} percentile daily maximum value to be less than 100 ppb.
- SO_2 has a 1-hour NAAQS, based on ranking the daily maximum one-hour values for each day in a year, selecting the 99^{th} percentile daily maximum, which must be less than 75 ppb.
- With PM2.5, SO_2, and NO_2, the 98^{th}/99^{th} percentile values are averaged with the similar statistic from the previous two years and then compared to the level of the NAAQS. For PM2.5, the annual average is averaged with the similar statistic from the previous two years and then compared to the level of the NAAQS.

No concentrations at levels that violate the National Ambient Air Quality Standards (NAAQS) have been seen at the GF station. Several recorded PM2.5 1-hour values exceeded the level of the 24-hour NAAQS, 35 $\mu g/m^3$, but as noted above, the NAAQS is not violated unless the 98^{th} percentile of 24-hour averaged concentrations in a year, averaged over three years violates the 24-hour NAAQS, or unless the overall annual average, averaged over three years, exceeds the level of the annual NAAQS (12 $\mu g/m^3$).

Figure 5 shows the hourly average time series for PM2.5 at the GF station from Jan. 1 through Mar. 28, 2021. The average concentration for the first quarter of 2021 was 6.8 $\mu g/m^3$ compared with the primary one-year NAAQS value (annual mean averaged over three years) of 12 $\mu g/m^3$.

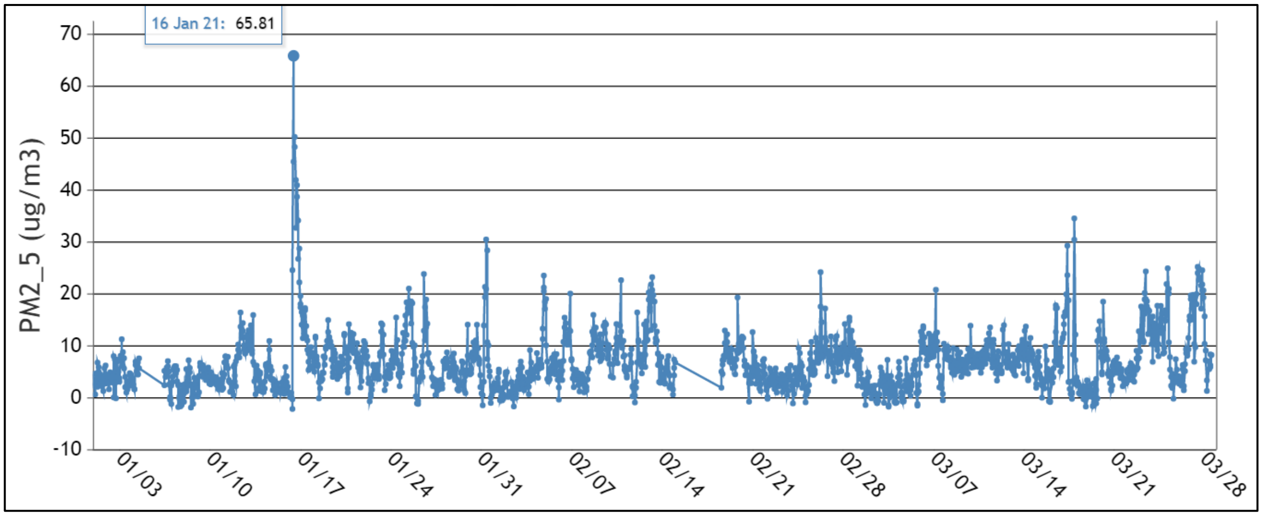

Figure 5. Hourly average PM2.5 at GF, μg/m^3, Jan. 1, 2021 – Mar. 28, 2021

Figure 6 shows the hourly average time series for NO_2 at the Gregory Fresnos station from Jan. 1 through Mar. 28, 2021. In the first quarter or 2021, the average NO_2 concentration at the Gregory Fresnos station was 3.9 ppb, and the highest daily maximum, shown in Figure 6, was 24.9 ppb. The NOx instrument had been out of service in late November into late December 2020, and again had stability of performance problems beginning January 24. On March 15, 2021, a replacement instrument began operating at the station. The length of time to diagnose/repair and replace the instrument was exacerbated by COVID 19 impacts and FREEZE 21. However, as this is the second time this instrument has failed, it will be replaced to prevent similar data loss in the future.

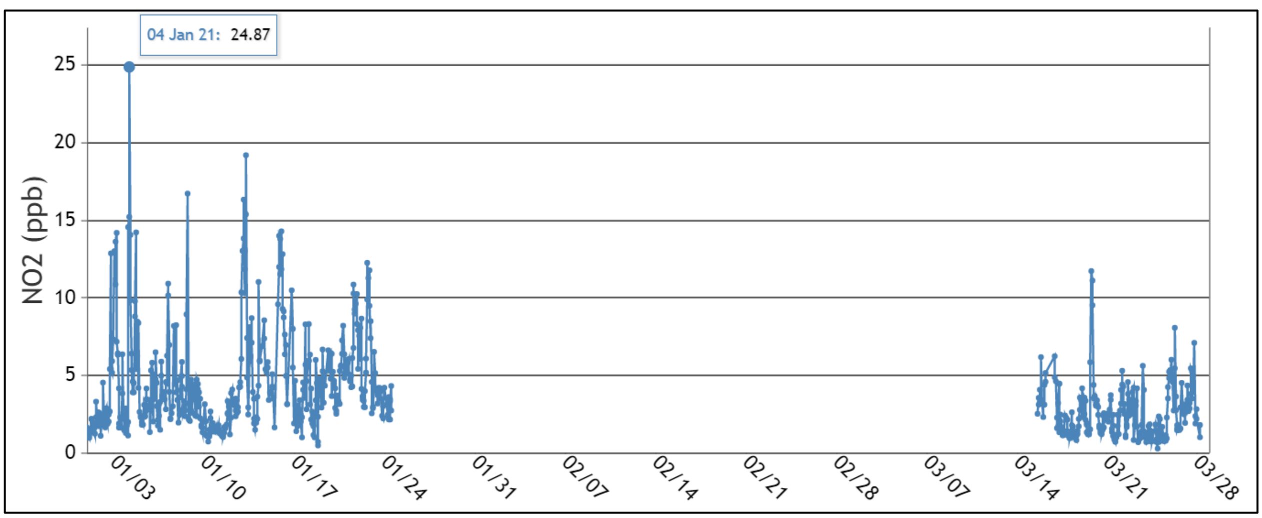

Figure 6. Hourly NO_2 at GF, ppb units, Jan. 1, 2021 – Mar. 28, 2021

Figure 7 shows the hourly average time series for SO_2 from Jan. 1 through Mar. 28, 2021. The average concentration of SO_2 measured to date is less than 1 part per billion (ppb) and no values significantly greater than 0.0 have been recorded in 2021. The NAAQS for SO_2 is the 99th percentile of daily one-hour maximum averaged over three years being less than 75 ppb. Because SO_2 is rarely found in ambient air, and the instruments are calibrated to accurately measure high concentrations that are a risk to public health, the concentrations close to 0.0 tend to fluctuate around 0, as illustrated in the graph. Many instruments measuring low concentrations will produce time series with much scatter near 0.0 owing to the nature of carrying out the chemical or electrical reaction that is associated with the measurement and converting that to a number representing the concentration. When an instrument has been calibrated to accurately measure high concentrations to safeguard public health, generally at low concentrations near zero there can be high relative error.

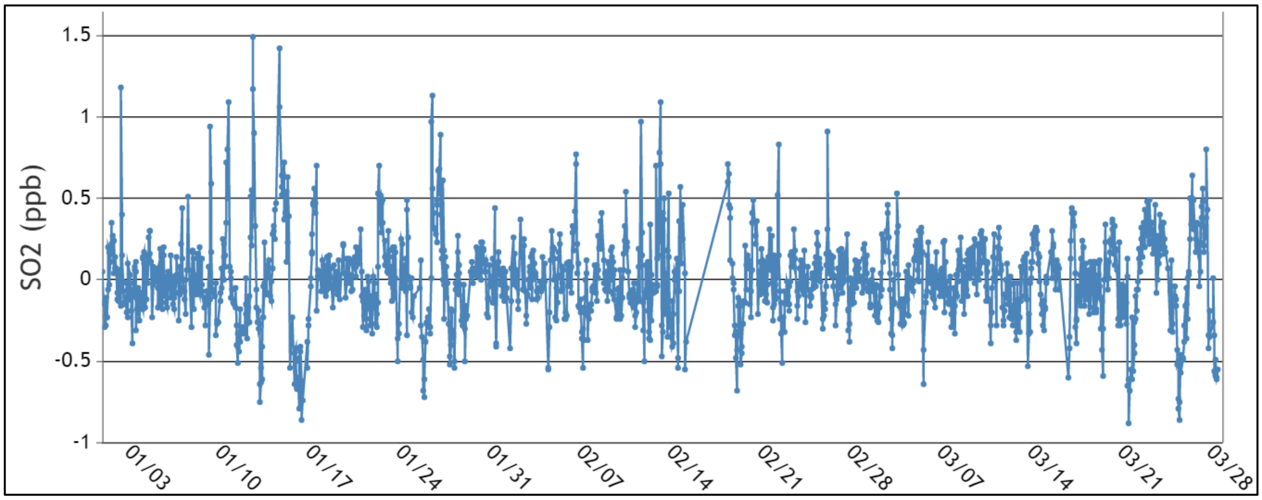

Figure 7. Hourly average SO_2 at GF, ppb units, Jan. 1, 2021 – Mar. 28, 2021

4.5 Portland Buddy Ganem & Portland Broadway Stations Criteria Pollutant Data

Fine particulate matter (PM2.5) is the only NAAQS-regulated pollutant measured at the PBG and PBway stations. Hourly concentrations that exceed the NAAQS 24-hour average value have been seen at the two stations, but no violations of the standard have occurred. Figure 8 shows the recent 2021 hourly concentrations of PM2.5 at the PBG site and Figure 9 shows the same for the PBway site. The average concentration in the first quarter of 2021 at PBG was 8.8 $\mu g/m^3$ and was 9.0 $\mu g/m^3$ at PBway.

The maximum one-hour PM2.5 values at all three project stations occurred on January 16. An explanation for the elevated PM2.5 on that date follows in Section 5.

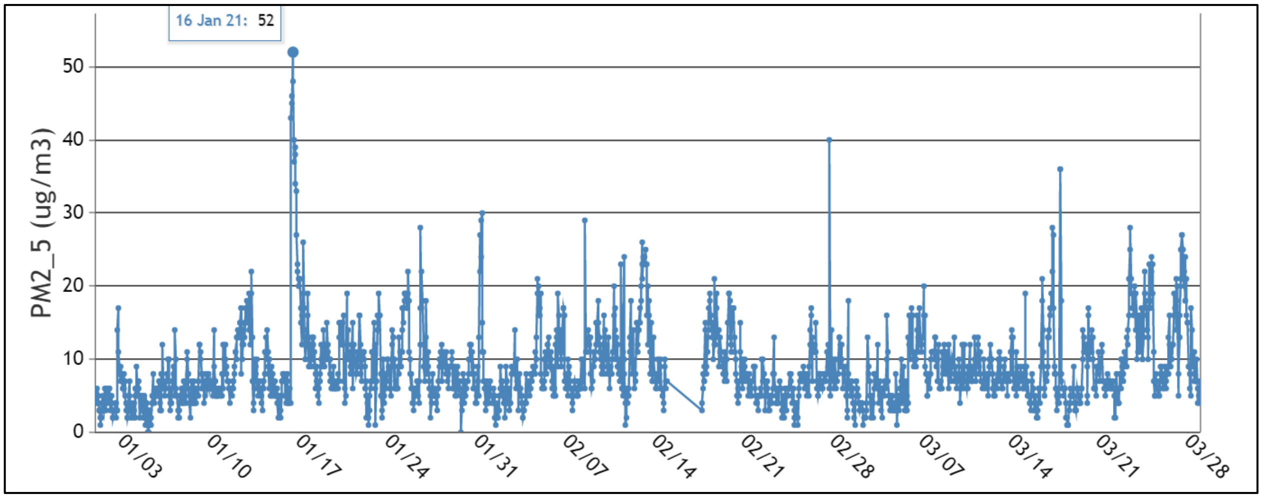

Figure 8. Hourly average PM2.5 at PBG, μg/m^3, Jan. 1, 2021 – Mar. 28, 2021

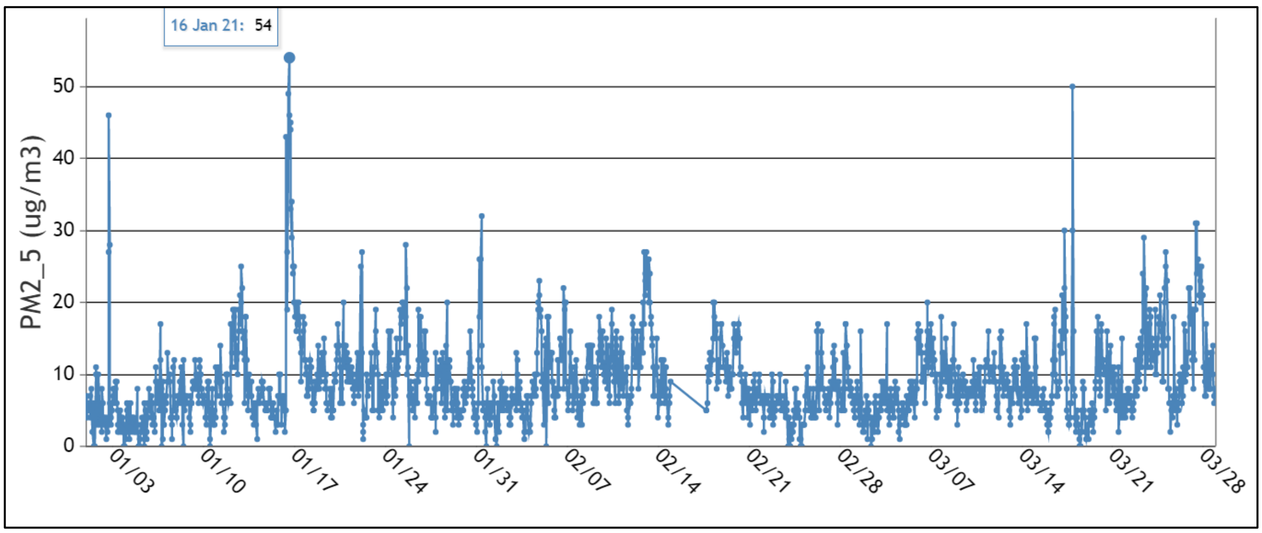

Figure 9. Hourly average PM2.5 at PBway, μg/m^3, Jan. 1, 2021 – Mar. 28, 2021

5.0 Data Analysis

Texas experienced elevated PM2.5 from dust carried by a frontal passage on January 15 and 16, 2021. Sequentially PM2.5 concentrations rose in north Texas and then later in the day in central and then in south Texas. Concentrations rose again in the Houston area on January 17, which may have been related to the same event. UT contacted the TCEQ Monitoring Division to enquire about the elevated concentrations, and the email exchange is below. Figure 10 is a satellite imagery of the dust cloud provided by the TCEQ Monitoring Division. Figure 11 shows average PM2.5 concentrations by TCEQ region by hour, with the Lubbock and Amarillo regions combined as "Panhandle", El Paso and Big Bend separated, and El Paso data converted to central standard time (CST). Figure 12 shows average PM2.5 concentrations at the three project monitors over the same period.

From: Sullivan, David W <sullivan231@mail.utexas.edu>
Sent: Wednesday, January 20, 2021 2:05 PM
To: Weslee Copeland <weslee.copeland@tceq.texas.gov>
Subject: Jan. 16 PM2.5

Wes

Looks like we saw elevated PM$_{2.5}$ across much of the state on Jan. 16. Was it all from the cold front passage?

Dave

From: Weslee Copeland [mailto:weslee.copeland@tceq.texas.gov]
Sent: Wednesday, January 20, 2021 3:38 PM
To: Sullivan, David W <sullivan231@mail.utexas.edu>
Subject: RE: Jan. 16 PM2.5

Hey Dave!

So what happened was the long range transport (behind the cold front) of suspended blowing dust that had been generated by strong winds last Thursday and Friday over the Texas and Oklahoma Panhandles as well as southwestern Kansas and eastern Colorado, which then settled over Central, South Central, and Southeast Texas. Definitely an interesting and unusual event!

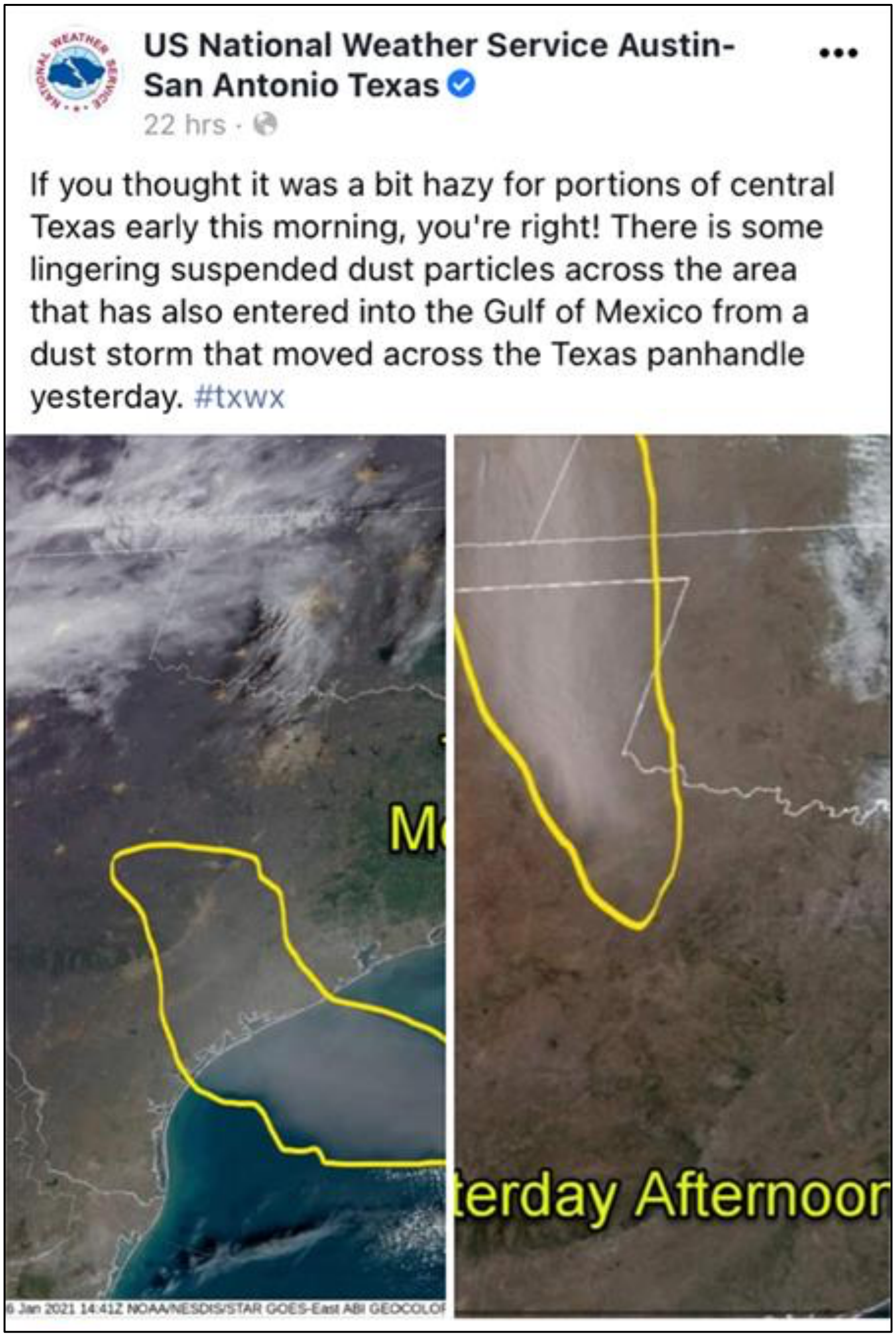

Figure 10. Image provided by Mr. Weslee Copeland, TCEQ meteorologist

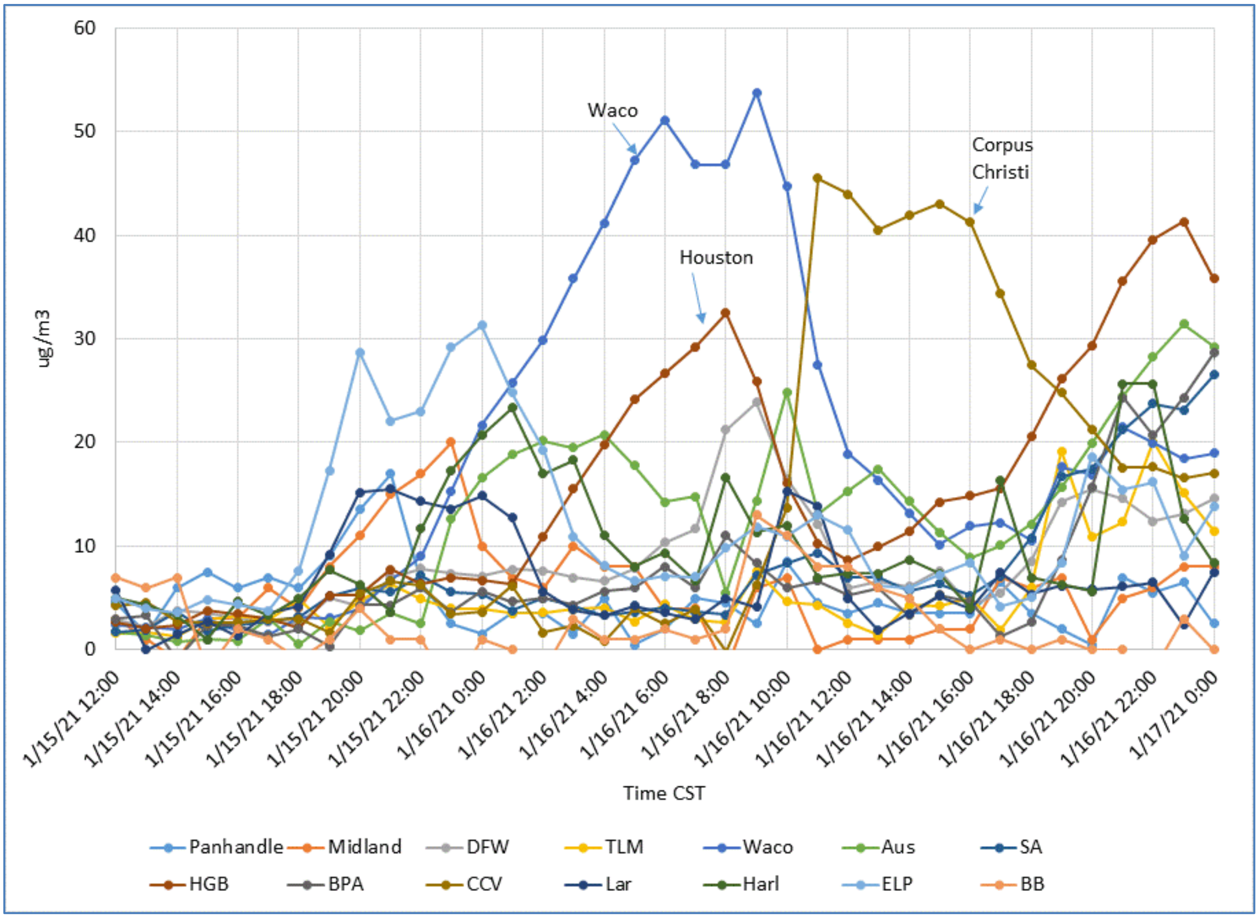

Figure 11. Jan. 15 – 16, 2021, average PM2.5 concentrations by TCEQ region by hour (Lubbock & Amarillo combined, El Paso & Big Bend separate, El Paso on CST)

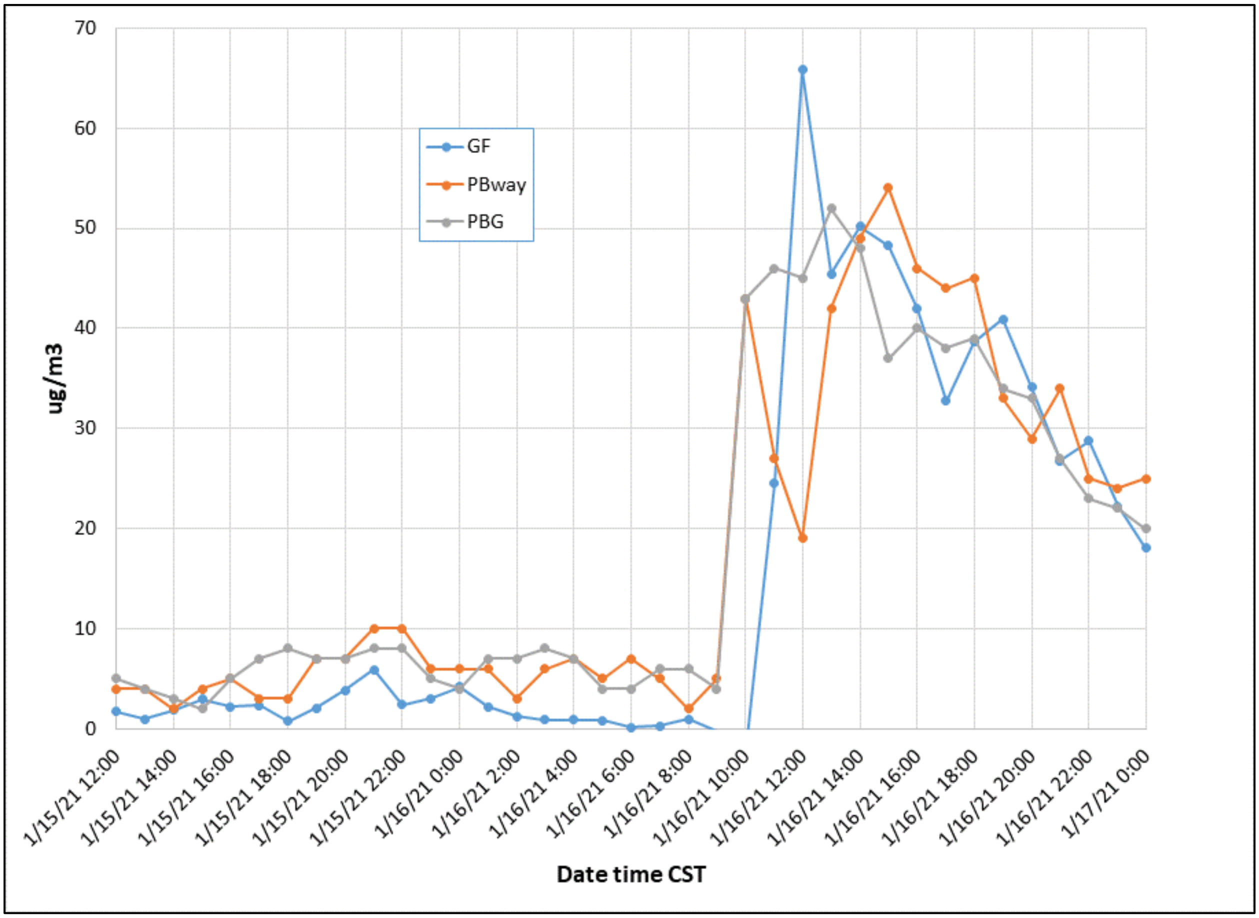

Figure 12. Jan. 15 – 16, 2021, average PM2.5 concentrations at Gregory-Portland monitoring stations

6.0 Conclusions

The air monitoring to date has been very successful. Although some concentrations have occasionally exceeded the concentration levels of the NAAQS, to date, the NAAQS have not been violated. Furthermore, measured hydrocarbon concentrations have not exceeded TCEQ long- term or short-term AMCVs. UT Austin would be happy to answer any questions or conduct additional analysis at the community's or sponsors' requests.

Appendices

A.1 Air Monitoring Station Locations & Information

Table A-1. Gregory-Portland Community Air Monitoring Stations and Parameters Measured

Air Monitoring Station Name & Address	Volatile Organic Compounds (VOCs) 46 compounds	Ethylene oxide (EO) 24 hr canister every 6th day	Nitrogen Oxides (NOx, NO, & NO_2)	Sulfur Dioxide (SO_2)	Particulate Matter (PM) Mass, particles < 2. 5 micron diameter	Wind Speed (WS), Wind Direction (WD), Ambient Temperature (T), Relative Humidity (RH), & Barometric Pressure (BP)
Gregory Fresnos Stephen Austin Elementary 401 Fresnos St. Gregory, TX	Yes	No	Yes	Yes	Yes	Yes
Portland Buddy Ganem 307 Buddy Ganem St. GP High School Portland, TX	Yes	Yes	No	No	Yes	Yes. + precipitation
Portland Broadway 175 Broadway Blvd. Old East Cliff Elementary School Portland, TX	Yes	Yes	No	No	Yes	Only WS, WD

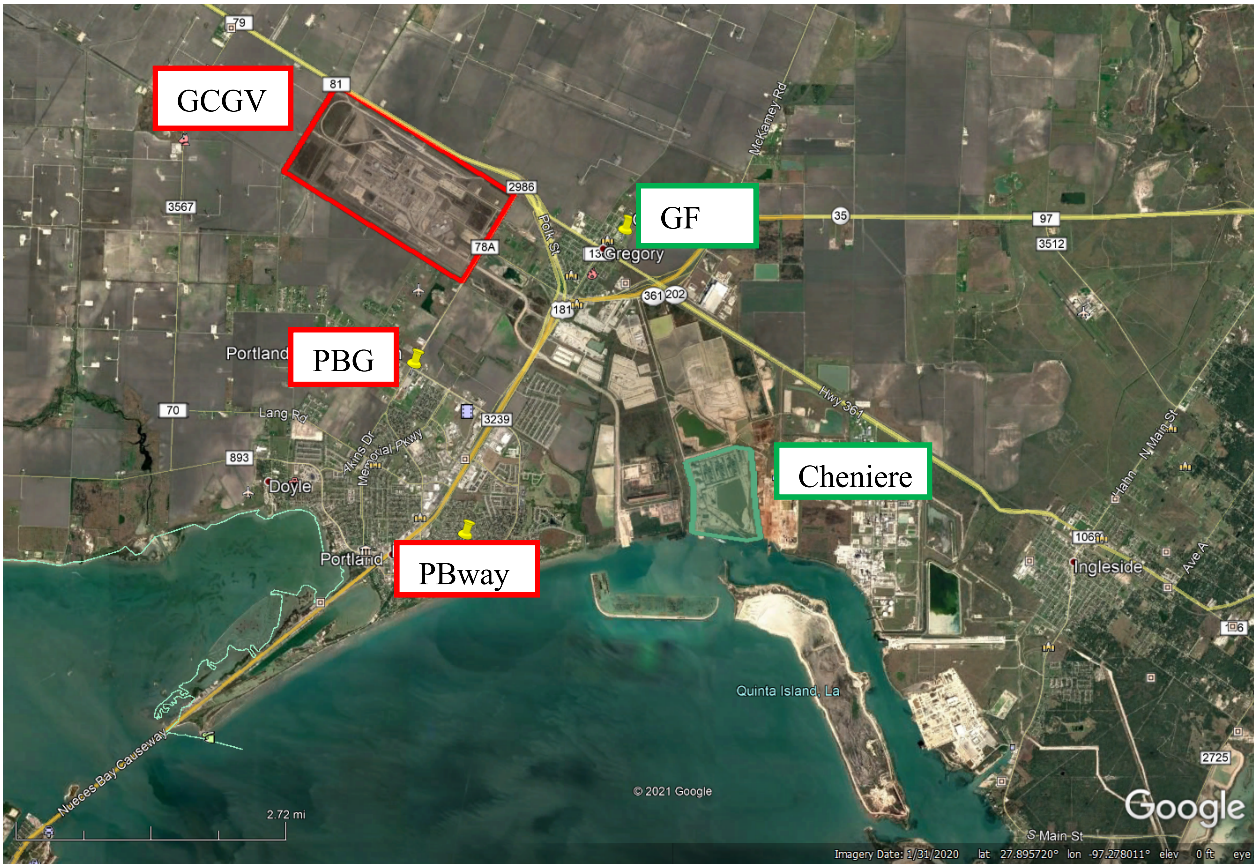

Figure 13. Location of Gregory-Fresnos Community Air Monitoring Station (GF), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG) and on Broadway (PBway) and the Cheniere Energy and GCGV industrial facilities

A.2 Glossary of Terms and Terminology

Pollutant concentrations – Concentrations of most gaseous pollutants are expressed in units denoting their "mixing ratio" in air; i.e., the ratio of the number molecules of the pollutant to the total number of molecules per unit volume of air. Because concentrations for all gases other than molecular oxygen, nitrogen, and argon are very low, the mixing ratios are usually scaled to express a concentration in terms of "parts per million" (ppm) or "parts per billion" (ppb).

Sometimes the units are explicitly expressed as ppm-volume (pp<u>mV</u>) or ppb-volume (pp<u>bV</u>) where 1 ppmV indicates that one molecule in one million molecules of ambient air is the compound of interest and 1 ppbV indicates that one molecule in one billion molecules of ambient air is the compound of interest. In general, air pollution standards and health effects screening levels are expressed in ppmV or ppbV units. Because hydrocarbon species may have a chemical reactivity related to the number of carbon atoms in the molecule, mixing ratios for these species are often expressed in ppb-carbon (ppbV times the number of carbon atoms in the molecule), to reflect the ratio of carbon atoms in that species to the total number of molecules in the volume. This is relevant to our measurement of auto-GC species and TNMHC, which are reported in ppbC units. For the purpose of relating hydrocarbons to health effects, this report notes hydrocarbon concentrations in converted ppbV units. However, because TNMHC is a composite of all species with different numbers of carbons, it cannot be converted to ppbV. Pollutant concentration measurements are time-stamped based on the start time of the sample, in Central Standard Time (CST), with sample duration noted.

Auto-GC – The automated gas chromatograph collects a sample for 40 minutes, and then automatically analyzes the sample for a target list of 46 hydrocarbon species. These include benzene and 1,3-butadiene, which are air toxics, various species that have relatively low odor thresholds, and a range of gasoline and vehicle exhaust components.

Total non-methane hydrocarbons (TNMHC) – TNMHC represent a large fraction of the total volatile organic compounds released into the air by human and natural processes. TNMHC is an unspeciated total of all hydrocarbons, and individual species must be resolved by other means, such as with canisters or auto-GCs.

Canister – Electro-polished stainless steel canisters are filled with air samples when an independent sensor detects that *elevated* (see below) levels of hydrocarbons (TNMHC) are present. Samples are taken for a set time period to capture the chemical make-up of the air.

Air Monitoring Comparison Values (AMCV) – The TCEQ uses AMCVs in assessing ambient data. Two valuable online documents ("Fact Sheet" and "Uses of ESLs and AMCVs Document") that explain AMCVs are at http://www.tceq.texas.gov/toxicology/AirToxics.html (accessed April 2021). The following text is an excerpt from the TCEQ "Fact Sheet" document:

Effects Screening Levels are chemical-specific air concentrations set to protect human health and welfare. Short-term ESLs are based on data concerning acute health effects, the potential for odors to be a nuisance, and effects on vegetation, while long-term ESLs are based on data concerning chronic health and vegetation effects. Health-based ESLs are set below levels where health effects would occur whereas welfare-based ESLs (odor and vegetation) are set based on effect threshold concentrations. The ESLs are screening levels, **not ambient air standards.**

Originally, the same long- and short-term ESLs were used for both air permitting and air monitoring.

There are significant differences between performing health effect reviews of air permits using ESLs, and the various forms of ambient air monitoring data. The Toxicology Division is using the term "air monitoring comparison values" (AMCVs) in evaluations of air monitoring data in order to make more meaningful comparisons. "AMCVs" is a collective term and refers to all odor-, vegetative-, and health-based values used in reviewing air monitoring data. Similar to ESLs, AMCVs are chemical-specific air concentrations set to protect human health and welfare. Different terminology is appropriate because air *permitting* and air *monitoring* programs are different.

Rationale for Differences between ESLs and AMCVs – A very specific difference between the permitting program and monitoring program is that permits are applied to one company or facility at a time, whereas monitors may collect data on emissions from several companies or facilities or other source types (e.g., motor vehicles). Thus, the protective ESL for permitting is set lower than the AMCV in anticipation that more than one permitted emission source may contribute to monitored concentrations.

National Ambient Air Quality Standards (NAAQS) – U.S. Environmental Protection Agency (EPA) has established a set of standards for several air pollutions described in the Federal Clean Air Act. NAAQS are defined in terms of *levels* of concentrations and particular *forms*. For example, the NAAQS for particulate matter with size at or less than microns ($PM_{2.5}$) has a *level* of 12 micrograms per cubic meter averaged over 24- hours, and a *form* of the annual average based on four quarterly averages, averaged over three years. Individual concentrations measured above the level of the NAAQS are called *exceedances*. The number calculated from a monitoring site's data to compare to the level of the standard is called the site's *design value*, and the highest design value in the area for a year is the regional design value used to assess overall NAAQS compliance. A monitor or a region that does not comply with a NAAQS is said to be *noncompliant*. At some point after a monitor or region has been in noncompliance, the U.S. EPA may choose to label the region as *nonattainment*. A nonattainment designation triggers requirements under the Federal Clean Air Act for the development of a plan to bring the region back into compliance. A more detailed description of NAAQS can be found on the EPA's Website at https://www.epa.gov/criteria-air-pollutants#self (accessed April 2021)

One species measured by this project and regulated by a NAAQS is sulfur dioxide (SO_2). EPA set the SO_2 NAAQS to include a level of 75 ppb averaged over one hour, with a form of the three year average of the annual 99th percentiles of the daily maximum one- hour averages. If measurements are taken for a full year at a monitor, then the 99th percentile would be the fourth highest daily one hour maximum. There is also a secondary SO_2 standard of 500 ppb over three hours, not to be exceeded more than once in any one year.

Elevated Concentrations – In the event that measured pollutant concentrations are above a set threshold they are referred to as "elevated concentrations." The values for these thresholds are summarized by pollutant below. As a precursor to reviewing the data, the reader should understand the term "*statistical significance*." In the event that a concentration is higher than one would typically measure over, say, the course of a week, then one might conclude that a specific transient assignable cause may have been a single upwind pollution source, because experience shows the probability of such a measurement occurring under normal operating conditions is small. Such an event may be labeled "statistically significant" at level 0.01, meaning the observed event is rare enough that it is not expected to happen more often than once in 100 trials. This does not necessarily imply the failure to meet a health-based standard. A discussion of "elevated concentrations" and "statistical significance" by pollutant type follows:

- For SO_2, any measured concentration greater than the level of the NAAQS, which is 75 ppb over one hour, is considered "elevated." Note that the concentrations of SO2 need not persist long enough to constitute an exceedance of the standard to be regarded as elevated. In addition, any closely spaced values that are statistically significantly (at 0.01 level) greater than the long-run average concentration for a period of one hour or more will be considered "elevated" because of their unusual appearance, as opposed to possible health consequence. The rationale for doing so is that unusually high concentrations at a monitor may suggest the existence of unmonitored concentrations closer to the source area that are potentially above the state's standards.
- For TNMHC, any measured concentration greater than the threshold of 2000 ppbC is considered "elevated."
- For benzene and other air toxics in canister samples or auto-GC measurements, any concentration above the AMCV is considered "elevated." Note that 40-minute auto-GC measurements are compared with the short-term AMCV.
- Some hydrocarbon species measured by the auto-GC generally appear in the air in very low concentrations close to the method detection level. Similar to the case above with SO_2, any values that are statistically significant (at 0.01 level) greater than the long-run average concentration at a given time or annual quarter will be considered "elevated" because of their unusual appearance, as opposed to possible health consequence. The rationale for doing so is that unusually high concentrations at a monitor may suggest an unusual emission event in the area upwind of the monitoring site.