

# **Corpus Christi Air Monitoring and Surveillance Camera and Neighborhood Air Toxics Modeling Projects**

**Annual Report to the US District Court  
by**

THE UNIVERSITY OF TEXAS AT AUSTIN



**Center for Energy and Environmental Resources**

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# Today's Presentation

- Introductions
- Objectives of today's presentation
- Project timelines
- Financial status of the projects
- Reflection on 7 years of the project and 5.5 years of data and modeling
- Looking beyond September 30, 2011
- Proposal for changes to the network
- Statement by the representative of the project's Voluntary Advisory Board
- Seek direction and/or approval from the Court on UT's proposal for continued operation of the network

# Air Monitoring & Surveillance Camera (AM & SC) Project Timeline

- Year 1
  - Hired contractors and began construction of 7 sites
  - Established Voluntary Advisory Board
- Year 2
  - Completed construction of sites, acceptance testing of sites & began reporting data March 2005 (collected data for 7 months of Year 2) through TCEQ & project websites
- Years 3 through 7
  - Continued collection & reporting of data; optimized operation of sites to maximize use of project funds
  - Project remains on schedule & within budget

# AM & SC Network Site Locations



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# AM & SC Project Budget History

- Of the total project costs for the first 7 years, site construction (1.5 years) and 4.5 years of operations & maintenance (O&M) costs have been funded by this project
- Additional funds provided by a Supplemental Environmental Project (SEP) awarded by the TCEQ funded O&M costs for one year, from October 1, 2005 to September 30, 2006
- Beginning October 1, 2006, all O&M costs have been charged to this project.
- Total expenditures for the first 7 years of the project included 4.5 years of O&M costs

# AM & SC Project Financial Status

## Expenditures

Total for prior years	\$4,999,060.58
Year ending 9/30/10	\$1,018,342.64
Total as of 9/30/10	\$6,017,403.22

## Funds Remaining

Initial deposit (10/2/03)	\$6,761,718.02
Less expenditures through 9/30/10	(\$6,017,403.22)
Plus interest earned through 9/30/10	\$770,941.23
Project funds remaining as of 9/30/10	\$1,515,256.03

# Summing Up the Schedule and Financial Status of the AM & SC Network Project

- On time and within budget
- Project funds remaining are estimated to allow the project to operate for at least one more year from September 30, 2010 (for a total of 8 years compared to initial estimate of 7 years) to at least September 30, 2011, assuming no extraordinary costs arise.

# Neighborhood Air Toxics Modeling (NATM) Project

Total Settlement Fund Allocation \$9,643,134.80

- Stage 1 - \$4,608,452.90<sup>\*\*\*</sup> (= \$4,586,014.92 + \$16,583.74\* + \$5,854.24\*\*)

Initial plan was to spend approximately half of the Stage 1 funds on the development of modeling tools and the other half on extension of the monitoring network as follows:

- Phase 1A - \$2,277,564.00<sup>\*\*\*</sup> (Modeling)
- Phase 1B - \$2,330,888.90<sup>\*\*\*</sup> (Monitoring Network Extension)

However, the modeling work was completed under budget and the remaining balance will be reallocated to extension of the monitoring network also.

- Stage 2 - \$5,057,119.88 (Undistributed pending appeal)

\* Interest earned by the US District Court prior to the distribution of funds.

\*\* Additional interest distributed by Garden City Group, August 2009.

\*\*\* Includes interest earned by the US District Court prior to the distribution of funds and additional interest distributed August 2009.



# NATM Project Financial Status

## Stage 1 Expenditures

Stage 1 - Phase 1A (Modeling) initial allocation	\$2,277,564.00
Less expenditures through December 31, 2010	(\$1,792,410.97)
Less outstanding encumbrances for FY 2011	(\$190,695.39)
Stage 1 - Phase 1A Project Funds Remaining	\$294,457.64

## Stage 1 Funds Remaining

Stage 1 - Phase 1A Project Funds Remaining	\$294,457.64
Stage 1 interest earned through December 31, 2010	\$290,599.60
Stage 1 – Phase B Allocation for the Air Monitoring Network	\$2,330,888.90
Total estimated Stage 1 funds for network extension	\$2,915,946.14

# Estimate of Funding Available at End of Year 8 (September 30, 2011)

Source of Funds	Amount
Stage 1 – NATM (\$2,330,889 + \$294,457 + \$290,600 =)	\$2,915,946
Sherwin Alumina SEP	\$10,800
Texas Molecular SEP	\$72,252
Equistar SEP (estimated)	\$150,000
AM & SC Project estimated balance on September 30, 2011	\$330,000
Total (plus future interest earned)	\$3,478,998
Stage 2 Settlement Funds (disposition still uncertain)	\$5,057,120

# SEP Funds Over the Years

Company	Amount	Interest Earned
CITGO Refining & Chemicals Company, LLP	\$870,000	\$27,935
Duke Energy Field Services	\$5,187	\$100
El Paso Merchant Energy Petroleum Company	\$136,048	\$7,075
Sherwin Alumina	\$10,244	\$557
Texas Molecular Corpus Christi Services, Ltd.	\$67,900	\$4,655
Equistar Chemicals, LP	\$150,000	\$0
Totals	\$1,238,479	\$40,322

# Total Funds Available for Extension of the Life of the Network

\$3,478,998  
(plus future interest earned)

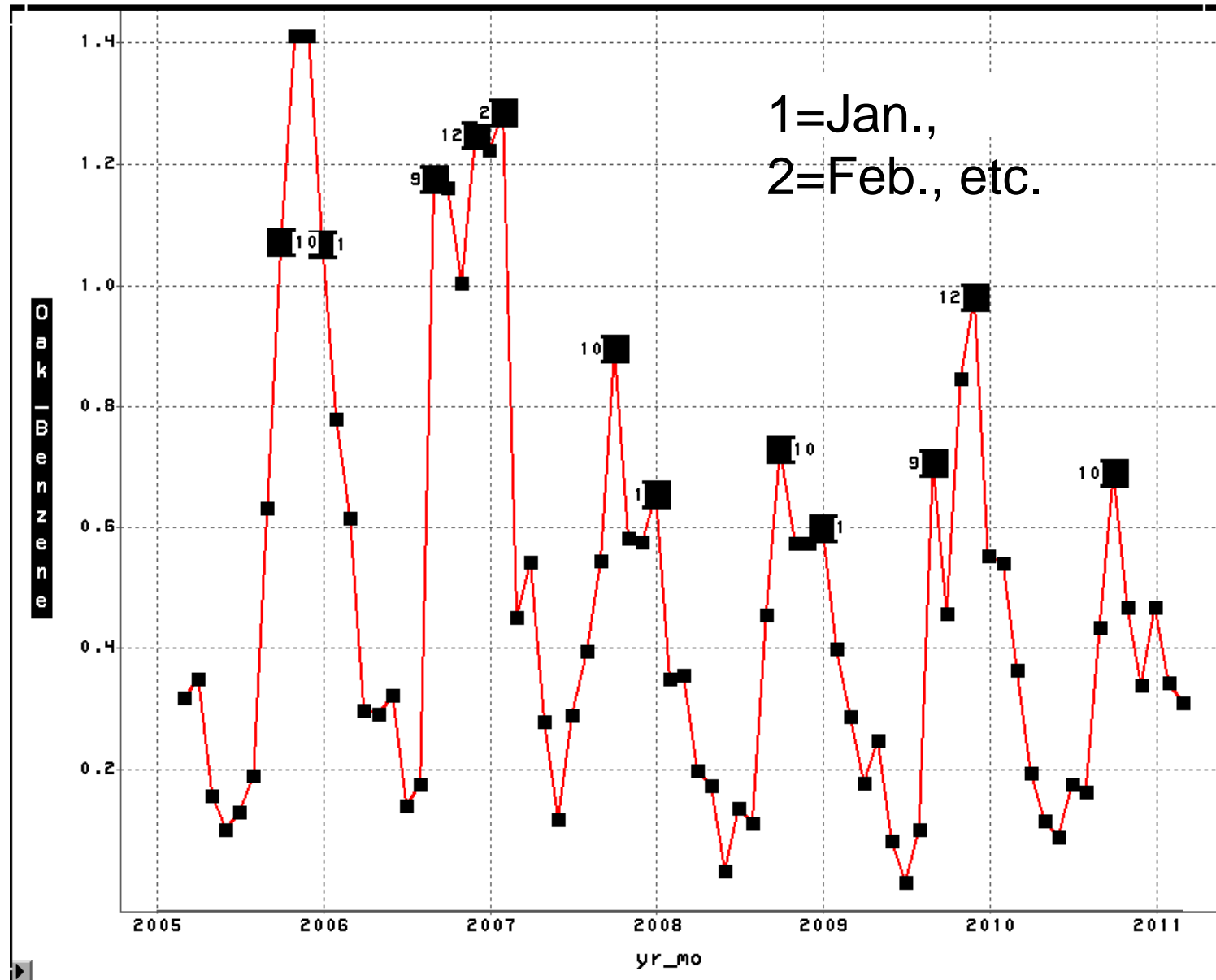
# Findings from the Corpus Christi Monitoring Network

Build Network 2003-2005  
Operate Network 2005-date

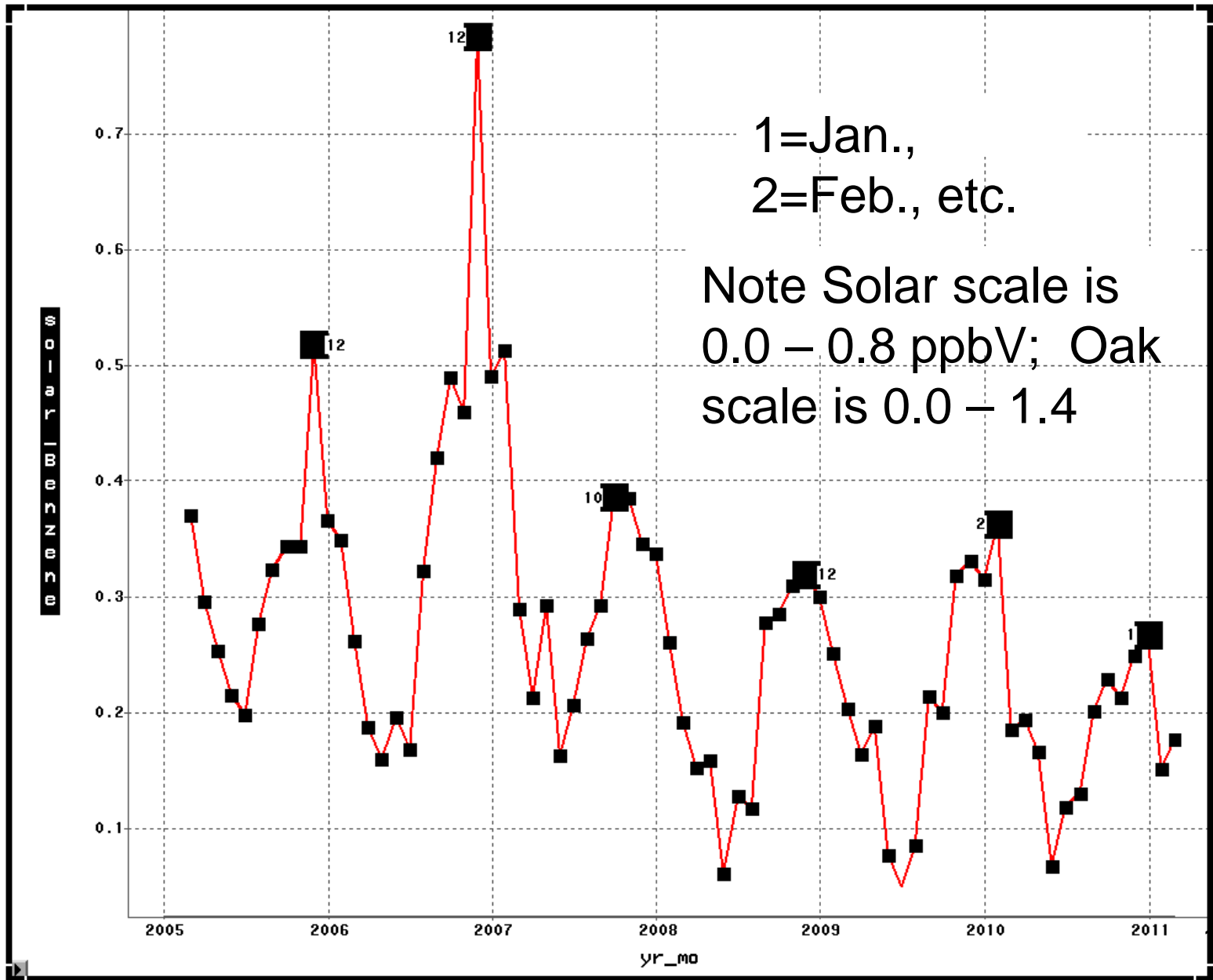
# Benzene trends in Corpus Christi 2005 - 2011

- Significant downward trend at both sites
- Strong seasonal pattern, higher concentrations in winter months
- Wind directions associated with peak mean concentrations point back to refineries

# Monthly benzene trend at Oak Park



# Monthly benzene trend at Solar Estates

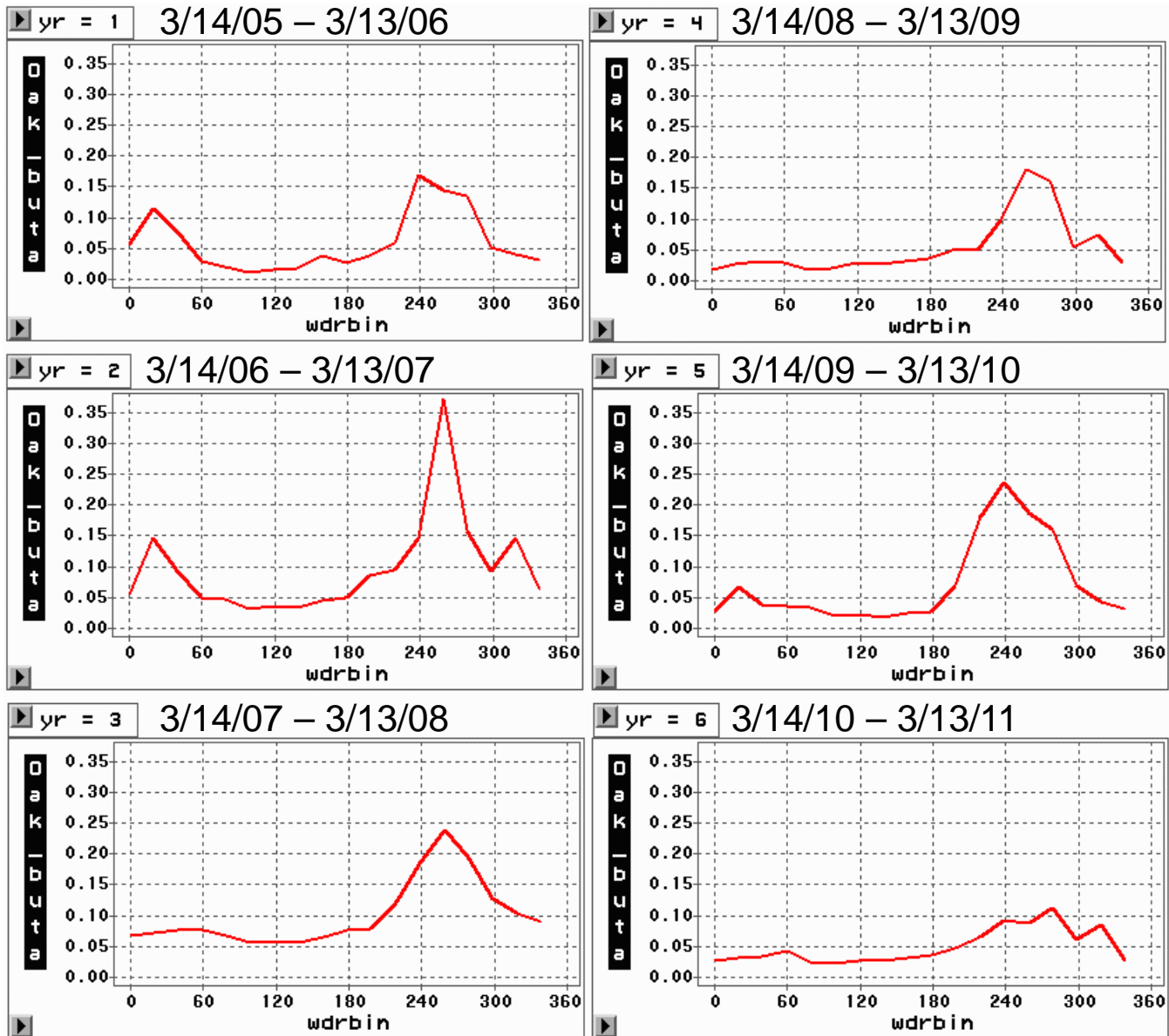




# 1,3-Butadiene Trends in Corpus Christi 2005 - 2011

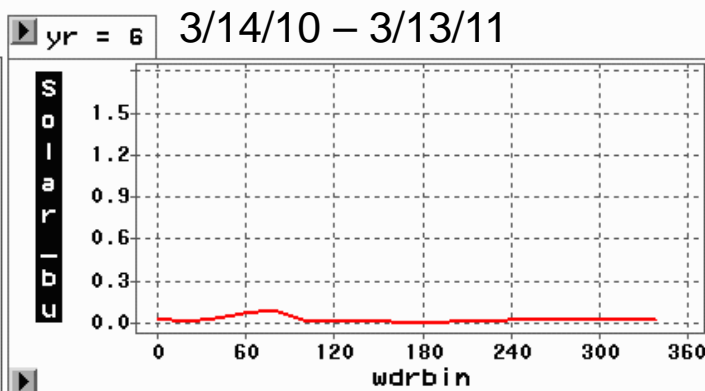
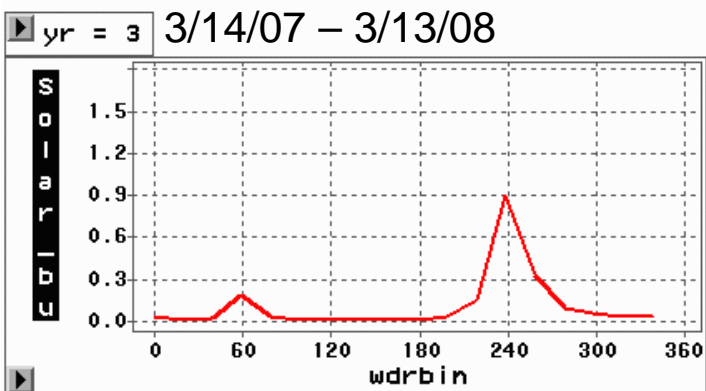
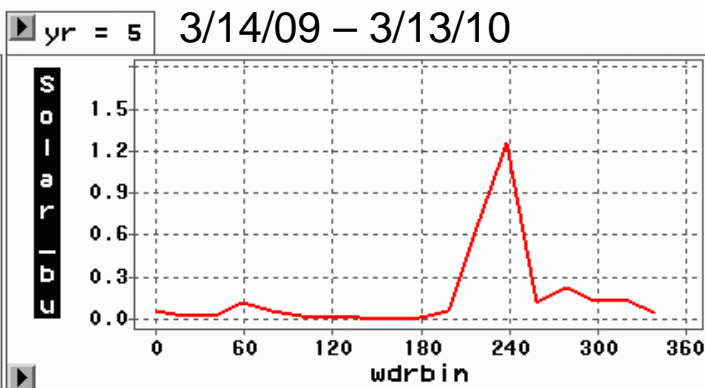
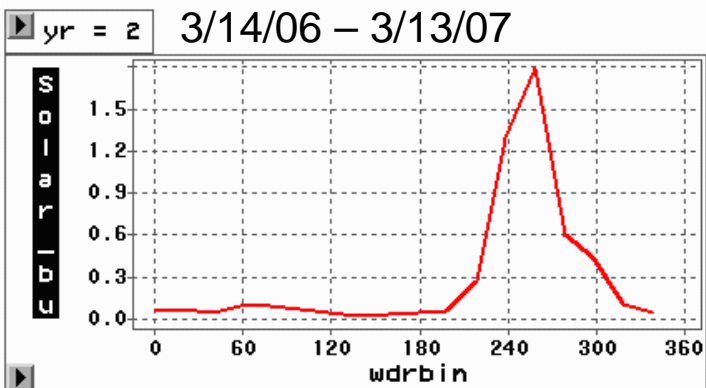
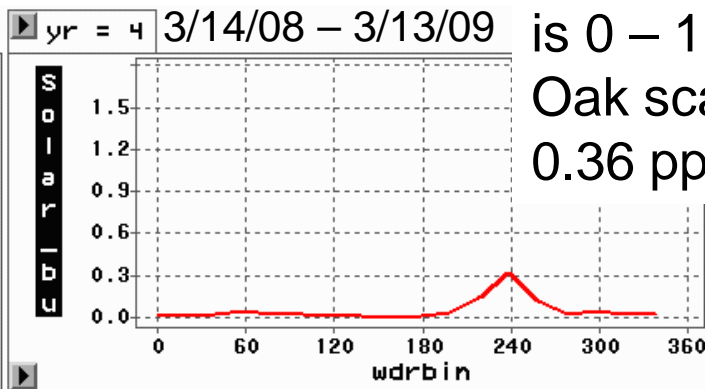
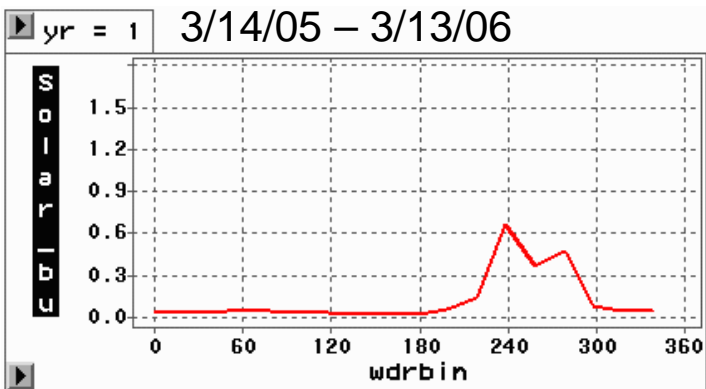
- No apparent seasonality at either site
- Mean concentrations are similar and low ( $< 0.05$  ppbV); however Solar Estates has seen statistically significant outliers
- Westerly winds associated with highest concentration at both sites
- Very significant decline in concentrations associated with westerly winds since 2009

# Oak Park mean 1,3-butadiene by wind direction, March – March years



# Solar Estates mean 1,3-butadiene by wind direction, March – March years

Note Solar scale is 0 – 1.8 ppbV;  
Oak scale is 0 – 0.36 ppbV



# SO<sub>2</sub> Issues in Corpus Christi

- Sulfur species (SO<sub>2</sub> and H<sub>2</sub>S) monitoring has been an important part of the network.
- In all previous years, concentrations measured for these species have been compliant with TCEQ and EPA standards.
- However, on June 2, 2010 a final rule was adopted to change (lower) the level and alter the form of the EPA standard.
- The JIH CAMS 630 site now does not comply with the EPA standard.

# SO<sub>2</sub> National Ambient Air Quality Standard

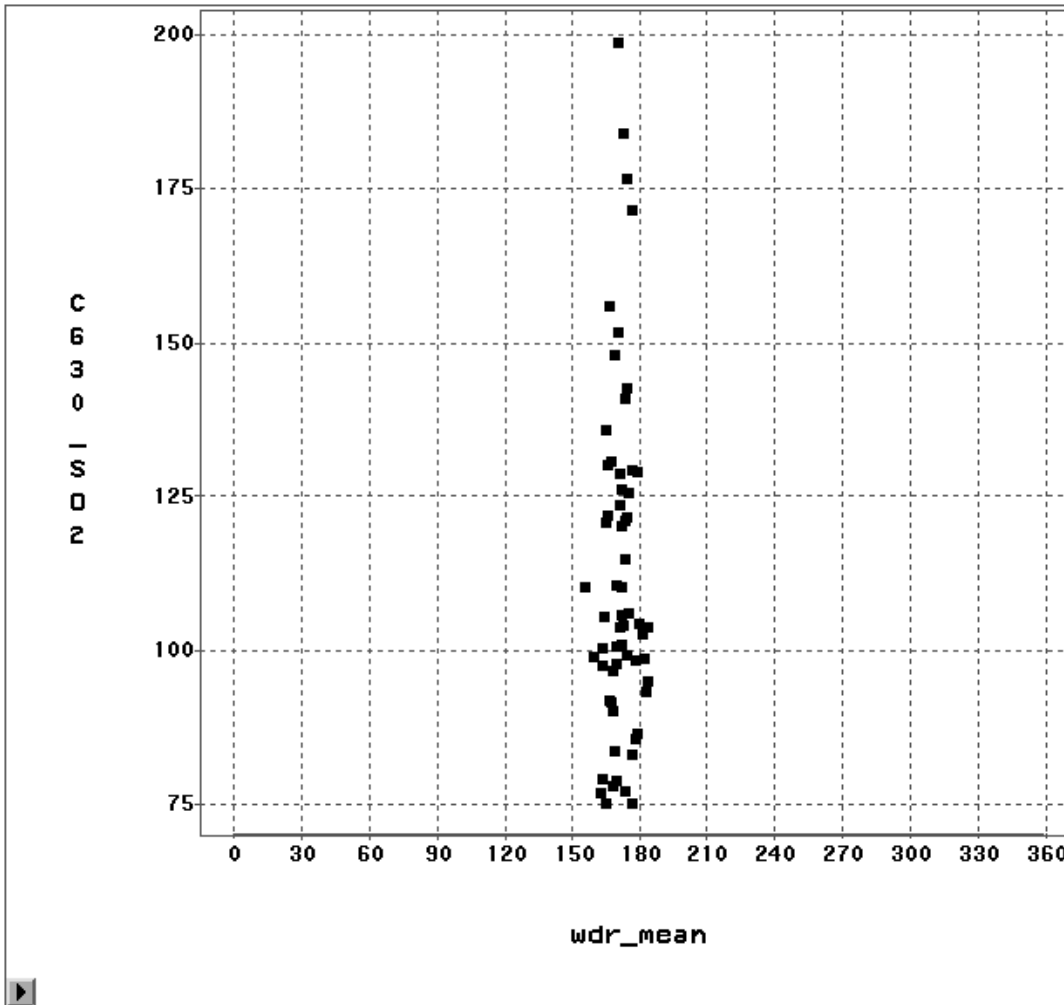
- New (6/2/2010) EPA standard (“NAAQS”) for SO<sub>2</sub> is based on the 3-year rolling average of 99<sup>th</sup> percentile of annual daily 1-hour SO<sub>2</sub> maximum.
- 99<sup>th</sup> percentile would be 4<sup>th</sup> highest daily maximum in a 365 day year. The resulting value is called the 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.
- The *design value* is compared with a level of 75 ppb to assess compliance.
- As of end of 2010, JIH CAMS 630 site in noncompliance with NAAQS.
- However, UT monitors are not regulatory sites, although UT does meet TCEQ standards.

# SO<sub>2</sub> NAAQS *design values* for Corpus Christi area sites, ppb

Values greater than 75 ppb represent noncompliance

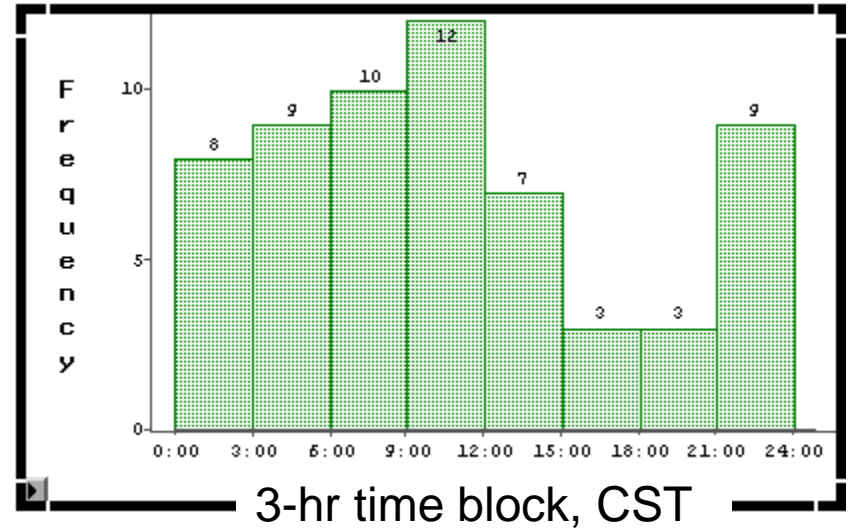
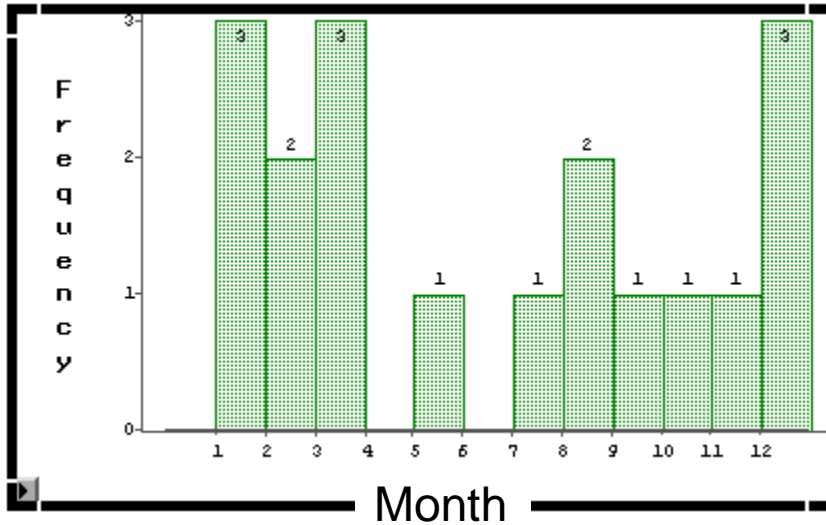
Year	C21	C4	C629	C630	C631	C632	C633	C635	C98
2007	8.3	23.9	33.6	118.7	38.0	20.6	50.5	34.4	36.1
2008	8.3	20.9	30.6	131.2	32.8	19.1	31.3	31.0	32.5
2009	8.6	17.6	29.8	88.9	32.4	16.6	20.9	22.7	27.7
2010	9.2	17.8	26.4	102.7	21.2	12.9	10.6	22.3	33.1

# JIH C630 SO<sub>2</sub> ≥ 75 ppb by Wind Direction Mean 2007 - 2010



- 61 hourly values on 18 dates
- Mean direction: 171.5 deg
- Wind speeds: 10 – 23 mph, mean=14.6 mph

# When do exceedances occur at JIH C630?



- Exceedances days happen year-round, more frequent in winter.
- Exceedance hours can happen any time of day, tend to be less frequent 3 – 9 pm CST



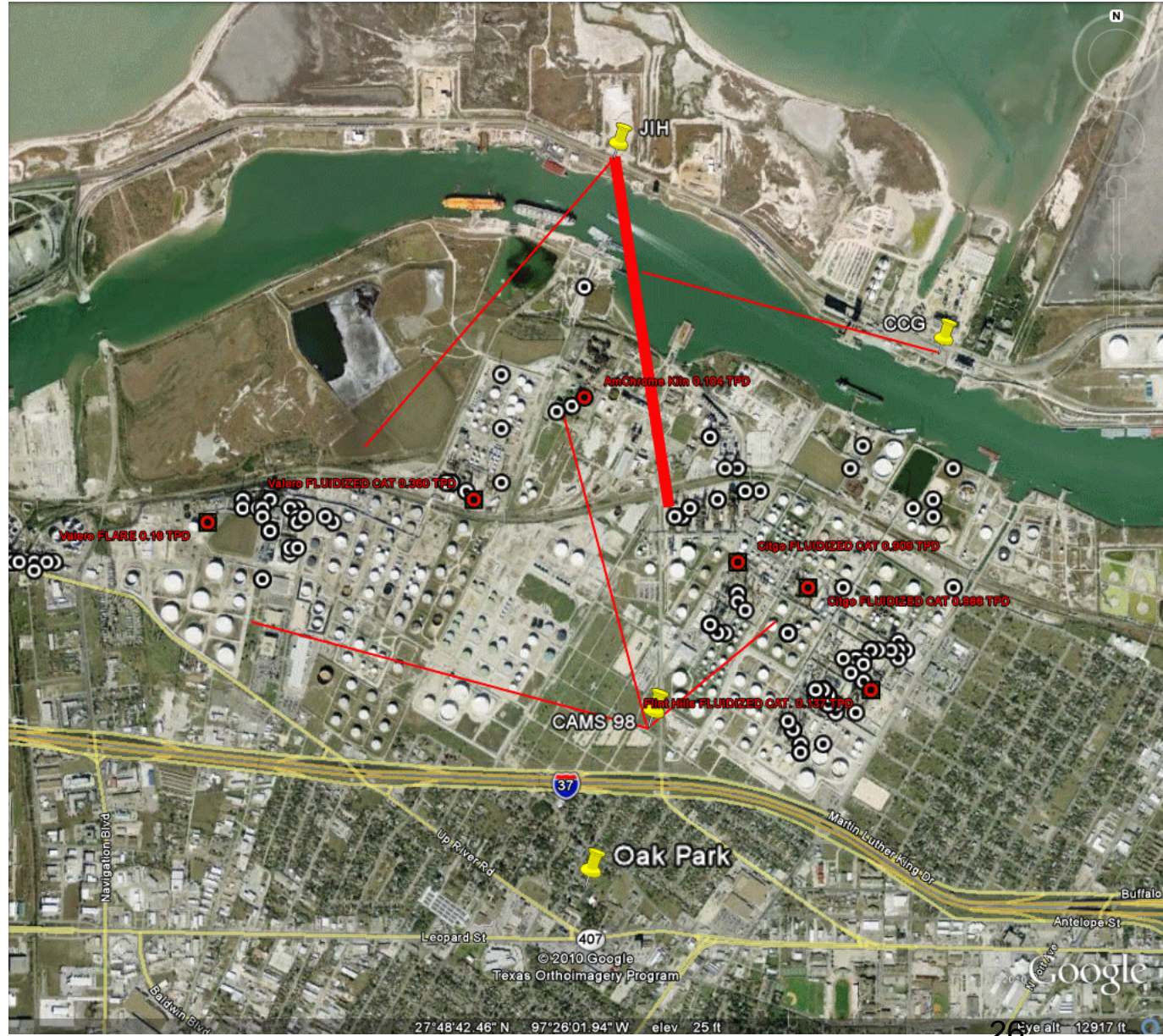
# 3 Recent JH SO<sub>2</sub> Episodes

Date	Time (CST)	C630 SO <sub>2</sub>	C630 H <sub>2</sub> S	C630 TNMHC	wind direction	speed mph
10/24/2010	20:00	98.3	0.4	156.2	169.7	9.7
11/10/2010	5:00	77.5	0.8	21.4	174.3	5.3
11/10/2010	6:00	110.9		21.0	169.1	6.0
11/10/2010	9:00	99.8	0.8	20.5	174.1	10.8
11/10/2010	10:00	75.6	0.6	27.8	176.5	10.8
11/10/2010	11:00	92.2	0.6	6.0	166.6	11.2
12/20/2010	21:00	79.6	0.5	80.6	163.1	10.3
12/20/2010	22:00	97.2	0.2	49.9	167.8	10.9
12/20/2010	23:00	106.4	0.2	20.8	171.6	10.8
12/21/2010	0:00	106.5	0.1	5.0	174.7	11.8
12/21/2010	1:00	143.0	0.2	5.0	173.9	12.1
12/21/2010	2:00	104.6	0.5	5.0	172.4	10.2

Other species at normal concentrations while SO<sub>2</sub> levels are high

# Rays drawn in key directions

- SO<sub>2</sub> point sources  
= white dots
- larger sources in  
red
- JIH sees two SO<sub>2</sub>  
sources, one  
nearby (i.e., ship),  
one at 187 deg.  
w/in southerly peak



# *Ships* are likely sources

- Several TexAQS II papers and EPA reports say diesel motors powering ships emit SO<sub>2</sub> but very little lighter hydrocarbons.<sup>1</sup>
- Several docks are located due south of JIH.
- At least one case study of JIH data relates the presence of a large ship coincident with SO<sub>2</sub> exceedances.

1. E. Williams, B. Lerner, P. Murphy, S. Herndon, M.S. Zahniser:

**Determination of Emission Factors from Commercial Marine Vessels** “Emission of SO<sub>2</sub> is quite variable from ships, depending on the fuel, but can be comparable to that from coal burning electric generating units.”

[www.epa.gov/ttn/chief/conference/ei17/session4/williams.pdf](http://www.epa.gov/ttn/chief/conference/ei17/session4/williams.pdf)

**Emissions of NO<sub>x</sub>, SO<sub>2</sub>, CO, and HCHO from commercial marine shipping during Texas Air Quality Study (TexAQS) 2006** J. OF Geophysical Res., vol 114, D21306, doi:10.1029/2009JD012094, 2009

# Actions Taken to Date

- UT alerted TCEQ to the JIH noncompliance issue Sept. 7, 2010.
- TCEQ has met with Port of Corpus Christi to discuss strategies to reduce emissions.
- UT is augmenting canister sampling at JIH to trigger cans on elevated SO<sub>2</sub>. This will provide additional information about the sources of the SO<sub>2</sub>
- Special quality assurance steps taken at JIH.
- UT continues to provide TCEQ with data and analysis results.

Looking to the future



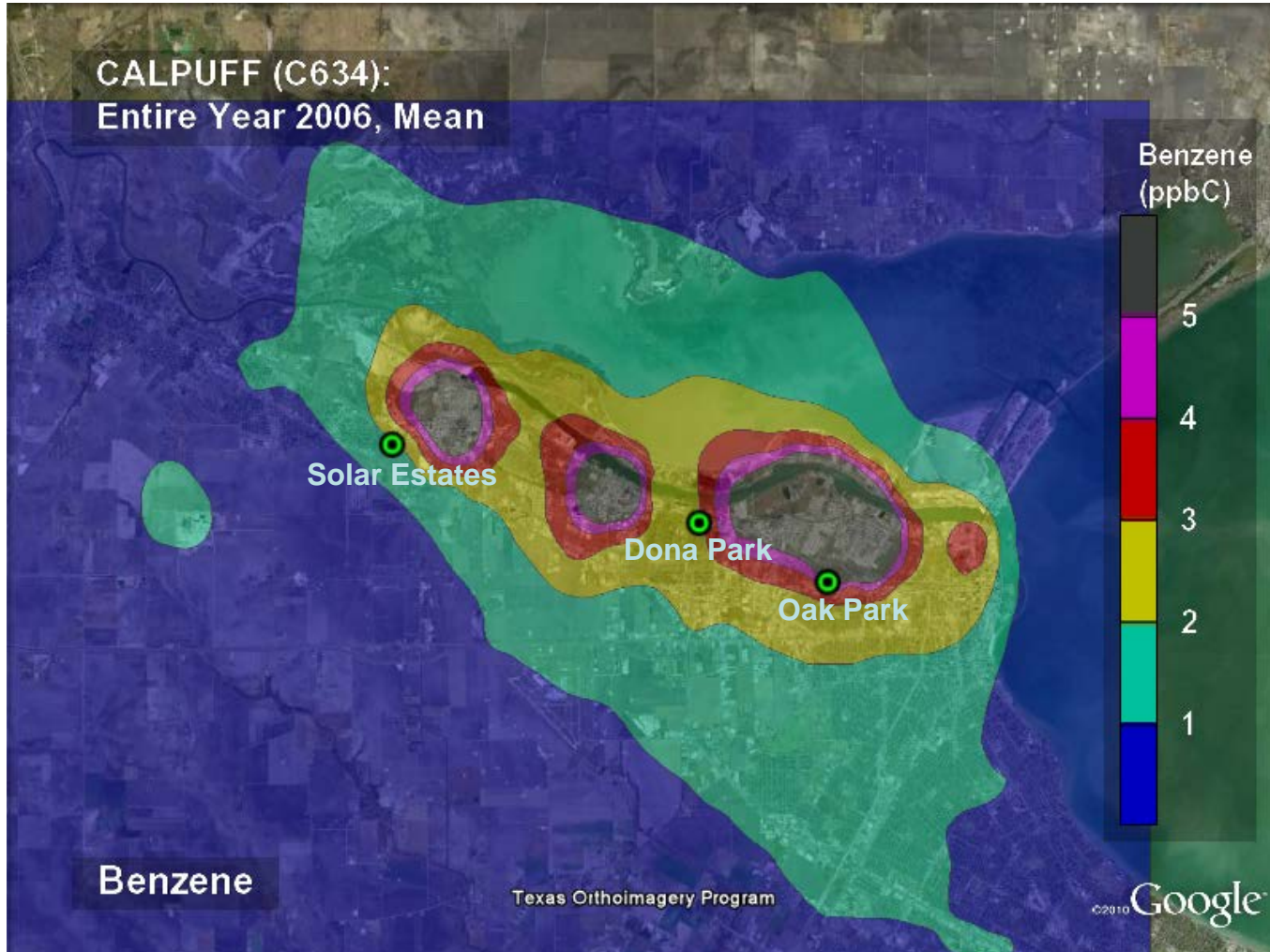
# Factors to Consider as We Look to the Future

- Monitoring equipment is reaching the end of its design lifetime
- Are there changes to the network that should be considered?
- UT has been working with the Advisory Board to develop a recommendation for a plan to evolve the network

# Key question

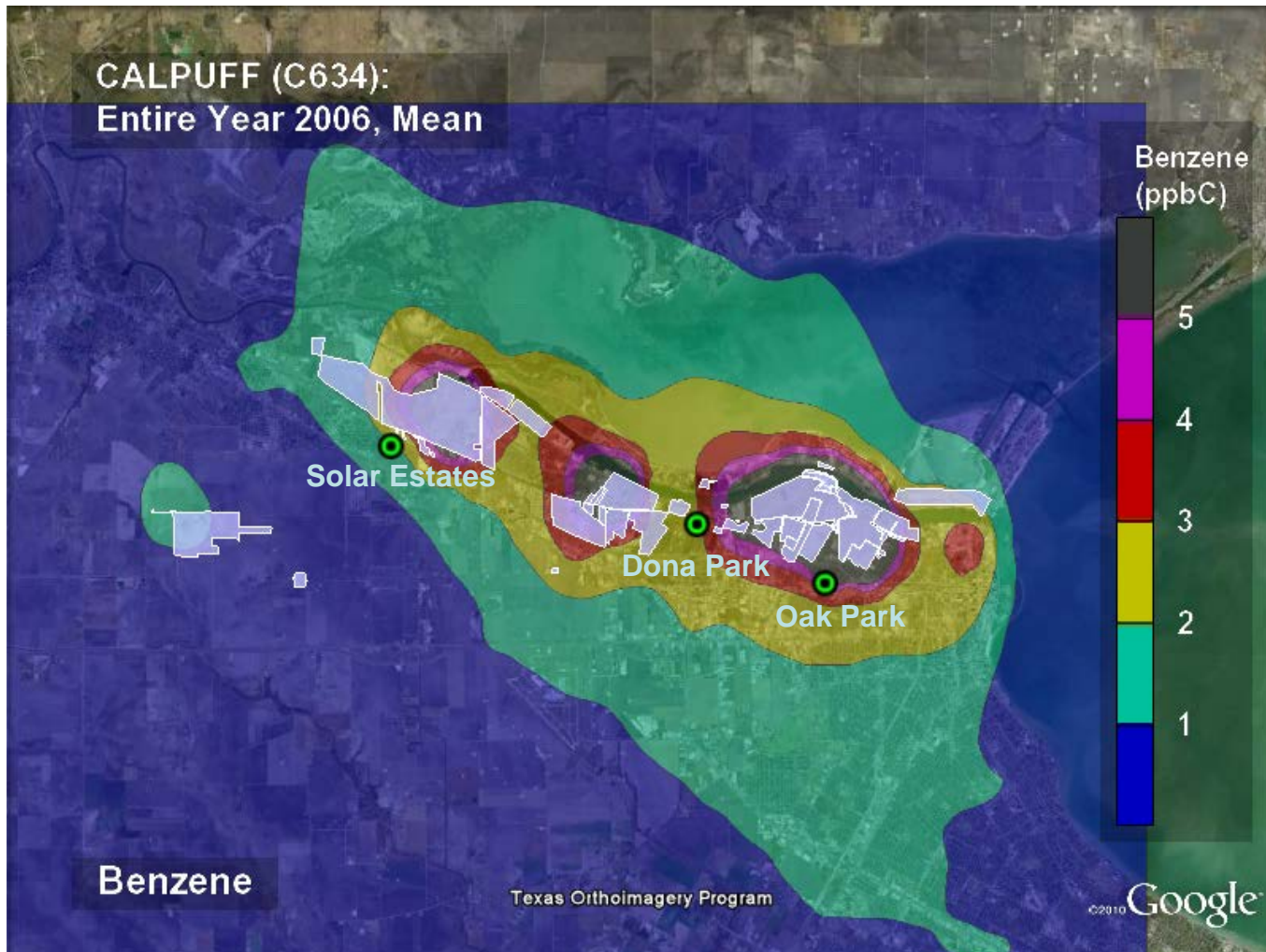
- Is the current network capturing all of the elevated concentrations?

# Modeling can indicate if monitors are capturing all regions with high expected concentrations: CALPUFF Predicted 2006 Annual Mean Benzene Concentrations





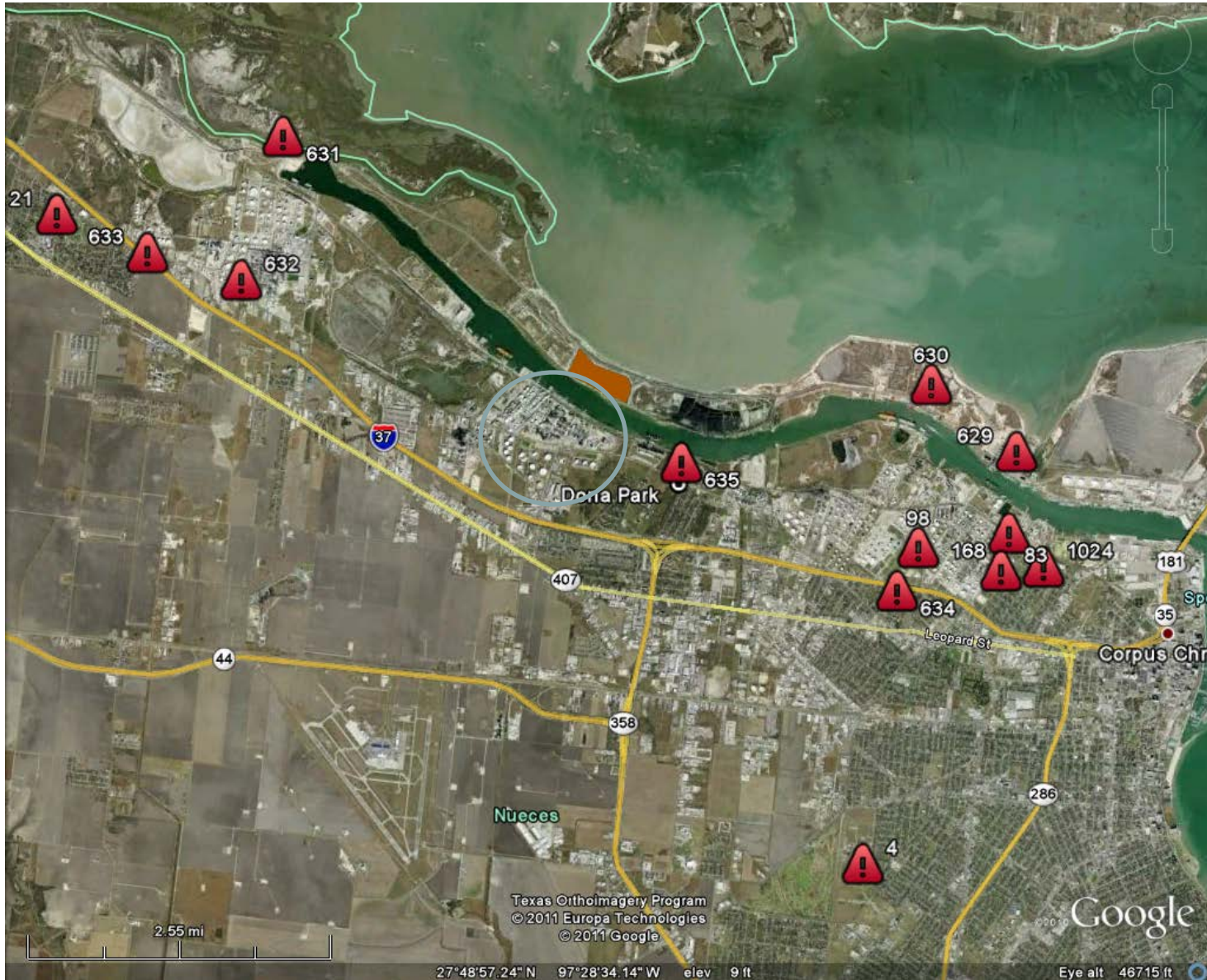
# CALPUFF Predicted 2006 Annual Mean Benzene Concentrations



# Potential Monitoring Changes in Corpus Christi Network

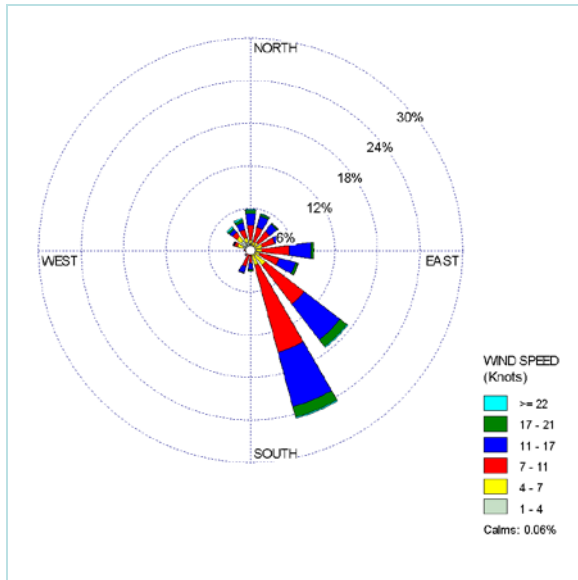
- Largest industrial source for which UT has collected little data: Valero West
- Additional new industries may locate along Joe Fulton corridor
- Where should a new site be located?
- Should we move an existing site?

# CC monitoring network, Valero West Refinery circled, possible new power plant in brown

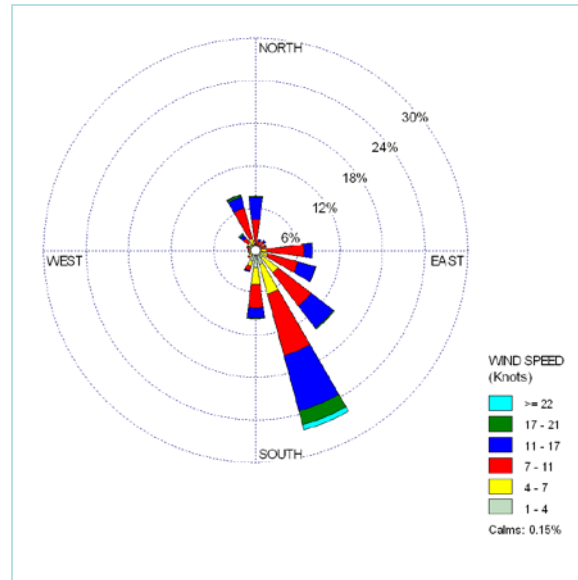


# Where the winds blow *from* in the monitoring network

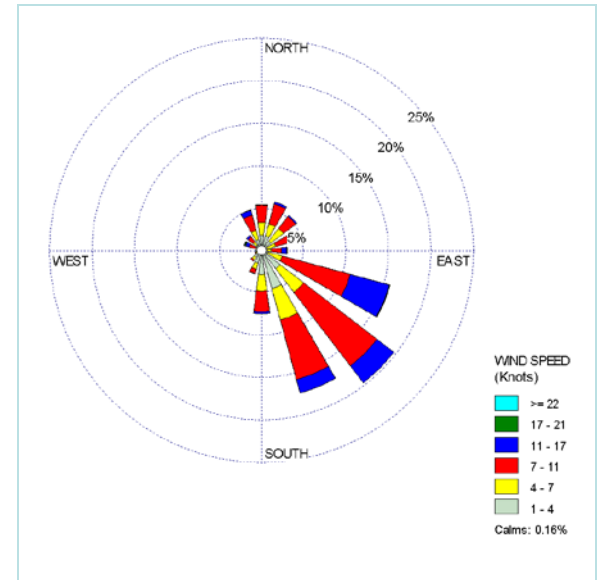
West End Harbor



Flint Hills Resources



Dona Park



Prevailing winds are from southeast.

West winds are least frequent.

One can combine wind roses to estimate “composite” winds.

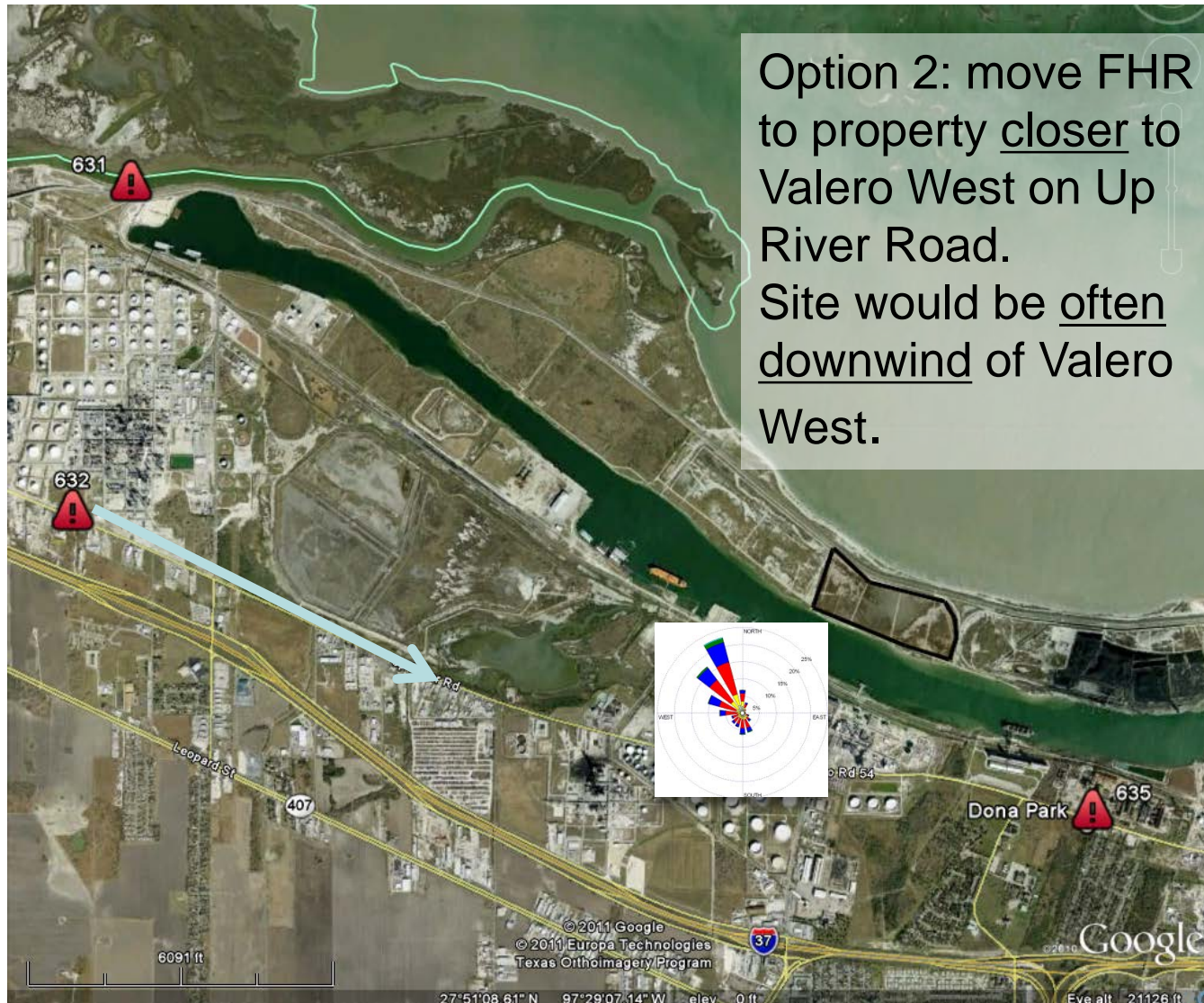
One can reverse the wind rose to show where the wind blows **to**.



# Composite wind rose showing where the wind blows *to* placed on Valero West



# Composite wind rose showing where the wind blows *to* placed on Valero West





# Potential Monitoring Changes in Corpus Christi Network

- Largest industrial source for which UT has collected little data: Valero West
- Monitoring site deemed to be providing the least valuable data: FHR CAMS 632
- Option 0 – no changes
- Option 1 – move FHR C632 to new location north of ship channel
- Option 2 – move FHR C632 to new location farther east on Up River Road.
- UT recommends Option 1 with Option 2 as a back-up

# Key questions

- Should we be monitoring for additional compounds?

UT recommends adding NO<sub>x</sub> monitors to auto-GC sites to help with source identification

UT recommends real time and filter based PM sampling in areas where there may be new sources; placement of monitors now would allow a baseline to be established



# Total Funds Available for Extension of the Life of the Network Life

**\$3,478,998**  
(plus future interest earned)

# AM & SC Network Sites and Major Instrumentation

Contract Reference	TCEQ CAMS No.	Description of Site Location	Major Monitoring Equipment/Systems				
			Auto GC	Event Triggered Sampler	H2S & SO2 Monitor	Meteorology Station	Surveillance Camera
1.a	634	Oak Park Recreation Center	Yes			Yes	
1.b	629	Grain Elevator @ Port of Corpus Christi		Yes	Yes	Yes	
1.c	630	J. I. Hailey Site @ Port of Corpus Christi		Yes	Yes	Yes	
1.d	635	TCEQ Monitoring Site C199 @ Dona Park		Yes	Yes	Yes	Yes
1.e	631	West End of CC Inner Harbor @ Port of Corpus Christi		Yes	Yes	Yes	
1.f	632	Off Up River Road on Flint Hills Resources easement		Yes	Yes	Yes	
1.g	633	Solar Estates Park at end of Sunshine Road	Yes		Yes	Yes	Yes

# Budgetary Estimates of Major Equipment Expenses over Next 3 Years

- Upgrades and preventive maintenance costs for the auto-GC systems - \$30,000 (recommended by UT)
- For other monitors, **complete** replacement of equipment (plus spares) and installation: hydrogen sulfide (7), sulfur dioxide (7), total non-methane hydrocarbon (8) analyzers, and multi-gas calibrators (10) would cost \$500,000 (selective replacement recommended by UT).

# Budgetary Estimates for Selected Expenses

No.	Item	Equipment & Installation	Annual Operating Cost
1	Network Operations & Maintenance (as is)		\$1,200,000
2	NOx Analyzer (each*)	\$25,000	\$12,000
3	PM (continuous)	\$50,000	\$12,000
4	PM (non continuous)	\$20,000	\$24,000
5	Relocate a Site	Up to \$60,000	

\* For this equipment, it is recommended that a spare unit also be purchased.

# UT Recommended Budget Scenario

Item	Cost
Replacement of 1 H <sub>2</sub> S and 1 SO <sub>2</sub> Monitor	\$12,000
Replacement of 2 TNMHC	\$48,000
Replacement of 3 Multi-gas Calibrators	\$42,000
Add 2 NOx Analyzers	\$50,000
Add 1 PM Continuous Monitor	\$50,000
Add 1 PM Non Continuous Monitor	\$20,000
Relocate 1 Site	\$60,000
Total	\$282,000
Balance Available for Operation of the Network	\$3,196,998

# Overall recommendation

- Continue to operate the network with minor modification
- Funds in hand will allow continued operation for approximately 3 years presuming no unexpected, major expenses
- Continue to seek funding from other sources