Ambient Air Toxics Monitoring at Kelly Elementary School Carlsbad, California

In early 2010, several members of the Carlsbad, California, community expressed concerns about the perceived number of cancer cases in some areas of Carlsbad and in particular the vicinity around Kelly Elementary School. The San Diego County Health and Human Services Agency (HHSA) formed a Community Task Force with residents to further explore these concerns. The HHSA held two Community Forums, one on April 28, 2010, and the other on June 28, 2010, to present the results of the analysis of local cancer cases to the residents. At the latter meeting, the San Diego County Air Pollution Control District (District) agreed to conduct monitoring at the school to test for the presence of the most prevalent cancer causing chemical compounds (carcinogens) in ambient (outdoor) air. This study would include common toxic compounds, heavy metals and other contaminants. A list containing the names of these compounds was made available to the community members before the study began and is included in Appendix A. The District worked closely with Carlsbad Unified School District officials to conduct this study at the school and their cooperation was appreciated.

The study indicated that the overall levels of volatile organic compounds and air toxics measured at the school were quite low and similar to the levels found in other parts of San Diego County.

Twenty-seven ambient air samples were collected at two sites within the perimeter of the Kelly Elementary School. A map showing the sampling locations is included in Figure 1. One sampling site (#1) was located outside of the temporary classroom number 29, across from the playground in the southwest corner of the school. The other site (#2) was located in the lunch area. Samples were collected for 24-hours on four separate days over a two week period. Sample collection days were Thursday, August 12; Tuesday, August 17; Thursday, August 19; and Saturday, August 21, 2010. Air samples were collected using three separate collection methods. One set of air samples was collected in 6-liter fused silica lined stainless steel canisters (Silco® cans) and were analyzed for selected toxic volatile organic compounds (VOCs). Additional air samples were collected on absorbent tubes for the detection of selected carbonyl compounds. Particulate matter present in the ambient air was captured on 37 mm Teflon filters which were analyzed for selected metals. The analytical methodologies used in this study are capable of identifying and quantifying the toxic air contaminants listed in Appendix A.

District staff analyzed the canister and absorbent tube samples for toxic VOCs, including carbonyl compounds, in the District's laboratory. The filters with the collected particulate matter were analyzed for selected metals by the California Air Resources Board (CARB) in their Sacramento laboratory. The District also operated a portable meteorological tower at the school (Figure 1, location #3) to continuously monitor wind speed and direction from

August 6 through September 1, 2010, in order to characterize the wind flow patterns in the school area. The wind data were used to create wind roses (graphical charts) that summarize wind flow patterns for the test area during this sampling period.

The air toxics data collected at Kelly Elementary School were compared with similar data collected in 2009 at other air quality monitoring sites in San Diego County to determine if unusual levels of any air toxics compounds were present at this school.

Results (The study had four components)**:**

i) **Toxic volatile organic compounds monitoring:** Eleven air samples were collected to quantify overall levels of selected toxic VOCs present in the outdoor air at the school. Replicate samples were collected at sampling site #1 to provide precision and accuracy in the quality control of the data collection process and the analyses procedures. Air samples for VOC analysis could not be collected on the first day of sampling in the lunch area (site #2) due to a problem with the power supply at this location. Subsequently, all other scheduled sample collections proceeded as planned. The VOC data for all sampling locations are presented in Table 1. The summary data from both of these sampling locations were compared to the data for similar compounds averaged for the 2009 calendar year from four other San Diego area monitoring sites. The data for this comparison are shown in Table 2.

ii) **Carbonyl compounds monitoring:** Eight air samples were collected to quantify levels of three carbonyl compounds present in the outdoor air at the school. The levels of these carbonyl compounds are presented in Table 3. The summary data from both school sites were compared to data for the same compounds averaged for the 2009 calendar year from four other San Diego area monitoring sites. The data from this comparison are shown in Table 4.

iii) **Metals monitoring:** Eight air samples were collected to quantify levels of selected metals present in the outdoor air in this area. The levels of these metals are presented in Table 5. Field blank samples were also collected during the scheduled sampling days to provide reliability in the quality control of the data collection and the analyses procedures. The summary data from both school sites were compared to data for similar compounds averaged for the 2009 calendar year from four other San Diego area monitoring sites. The data from this comparison are shown in Table 6.

iv) **Meteorological monitoring:** Hourly averages of several meteorological parameters were measured from August 6 through September 1, 2010. These included ambient temperature (TMP), dew-point temperature (Td), relative humidity (RH), wind speed (WS), wind direction (WD), the standard deviation of the horizontal wind direction (SigmaT), minimum and maximum wind speeds, solar radiation (SORD) and barometric pressure (BP). Meteorological data collection efficiency during the study was excellent. The wind roses show the percentage of time the wind blows from a given quadrant with speed ranges for all hours of the day.

The wind rose for August 12, 2010 (Figure 2) showed the wind blew from the southwest and north-northwest quadrants. The northerly wind represents weak nighttime flow. Average wind flow patterns for the rest of the sampling days (see Figures 3 through 5) were similar and showed the wind blowing predominately from the southwestern quadrant. This average wind pattern shows the typically onshore wind is influenced by the local terrain. The summary wind rose for the period August 6 through September 1 is shown in Figure 6.

Conclusion:

The study indicated the overall levels of volatile organic compounds and air toxics present in the outdoor air at this school were very low and similar to the levels found in other parts of San Diego County. However, elevated levels of methyl bromide (the highest level was recorded at 3 ppb) were detected on August 17, 2010 during the study. The levels of methyl bromide measured at the site decreased significantly by the end of the study period. Records provided by the County of San Diego Department of Agriculture, Weights and Measures (AWM) indicated that permits were issued to various agricultural farms in the Carlsbad area for the application of methyl bromide as a soil fumigant. The slightly elevated levels of methyl bromide corresponded to the time when fumigants were used in areas upwind of the school. According to AWM, the Methyl Bromide levels were 1000 times less that would be allowed for reoccupation of a home that had been fumigated with this material for termites. The EPA has classified methyl bromide as a "Group D, not classifiable as a human carcinogen." However, methyl bromide is classified as a "Class I" ozone-depleting substance due to its high ozone depletion potential. Additional information on methyl bromide can be found on the Agency for Toxic Substances & Disease Registry (ATSDR). A link to this information is provided below:

http://www.atsdr.cdc.gov/phs/phs.asp?id=820&tid=160

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Figure 1: Sampling site locations

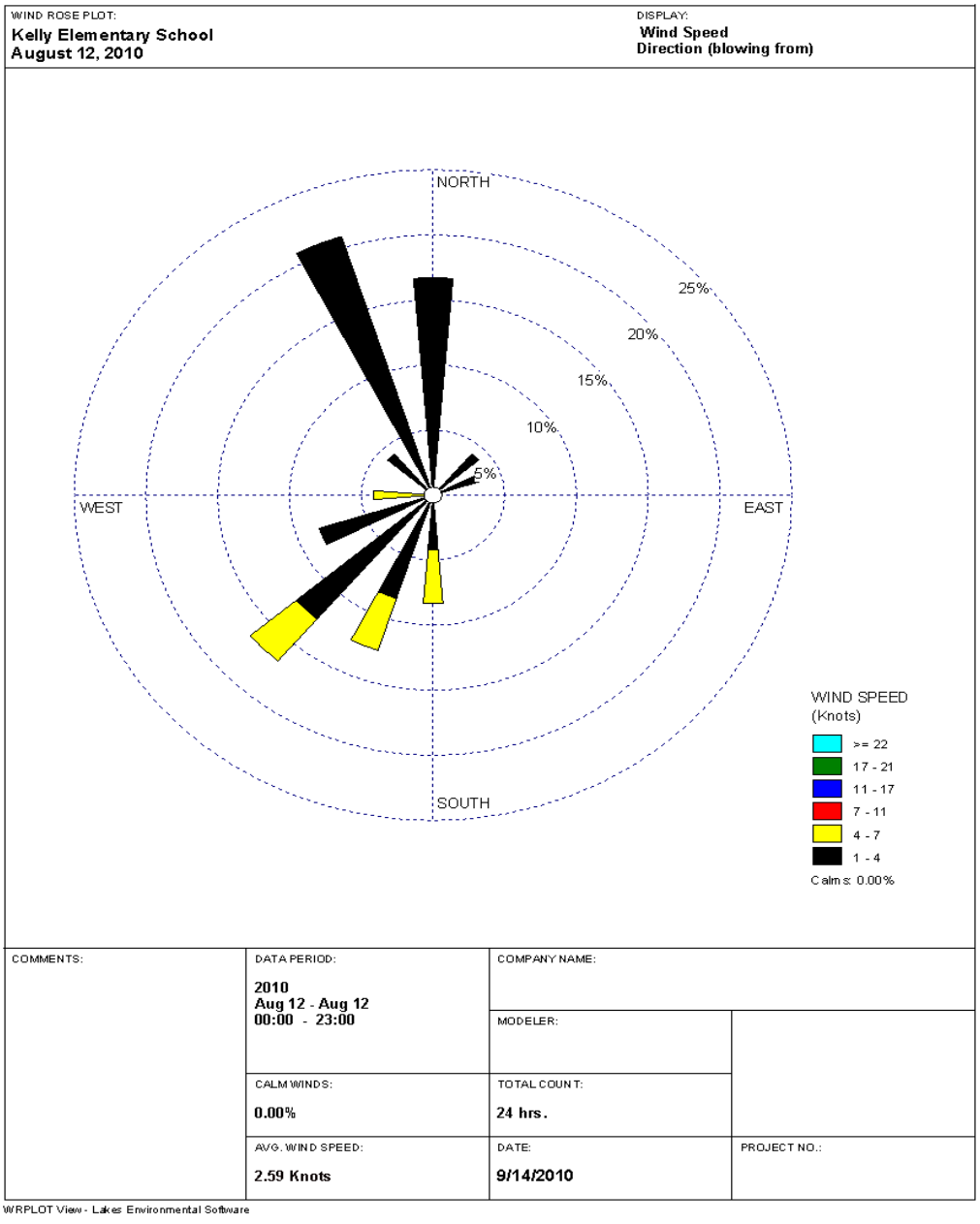

Figure 2: Wind rose for Kelly Elementary School, August 12, 2010.

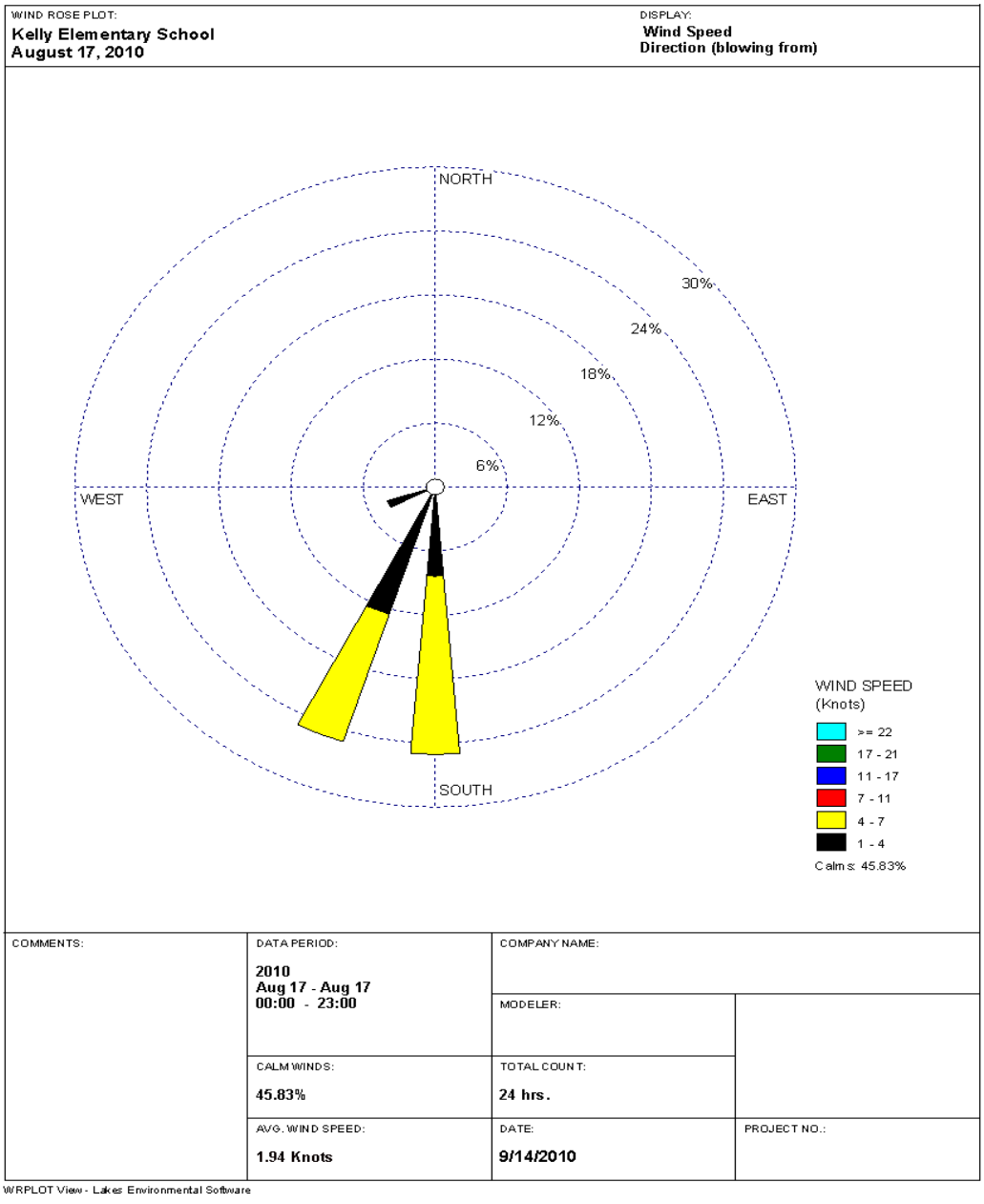

Figure 3: Wind rose for Kelly Elementary School, August 17, 2010.

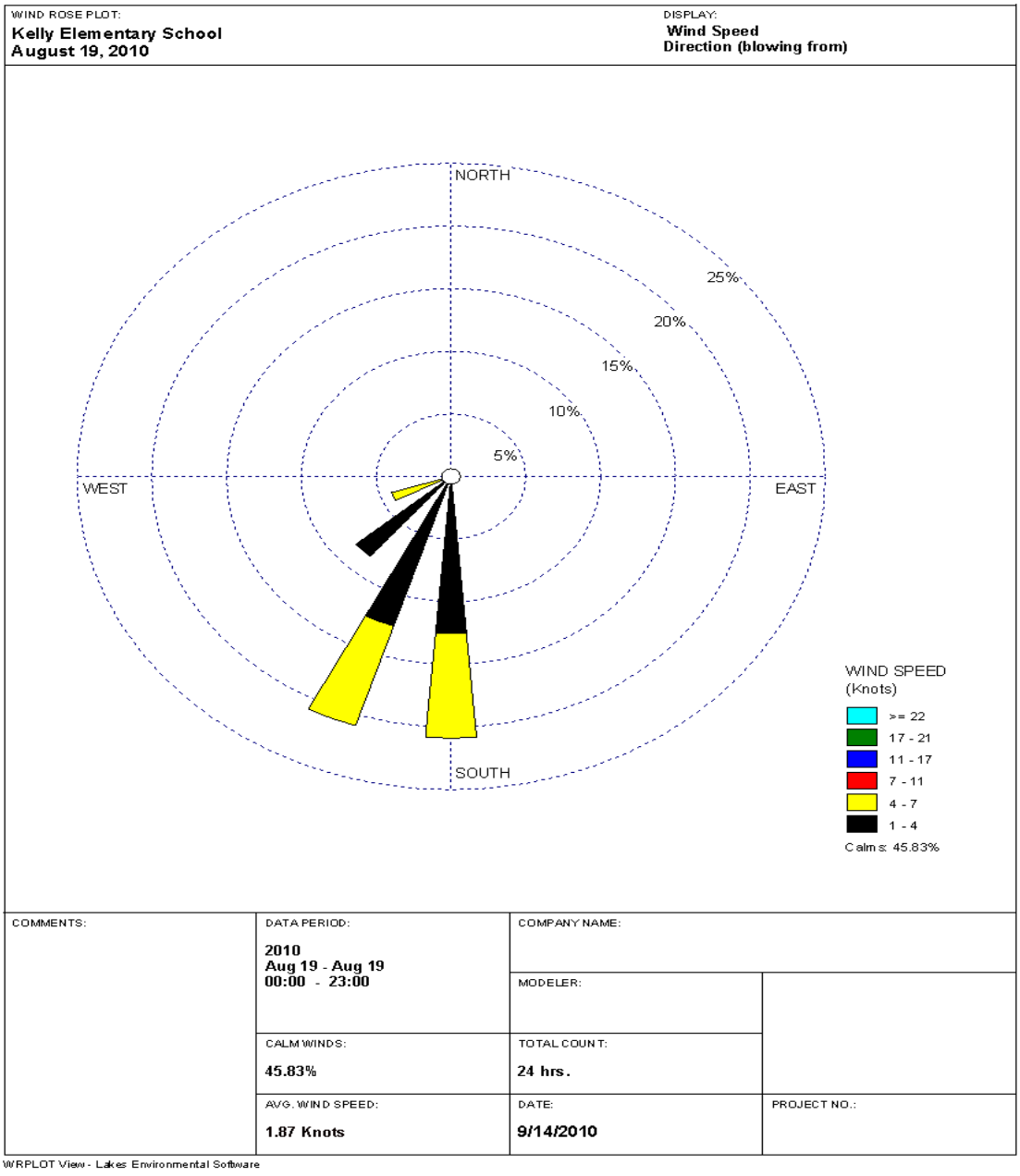

Figure 4: Wind rose for Kelly Elementary School, August 19, 2010.

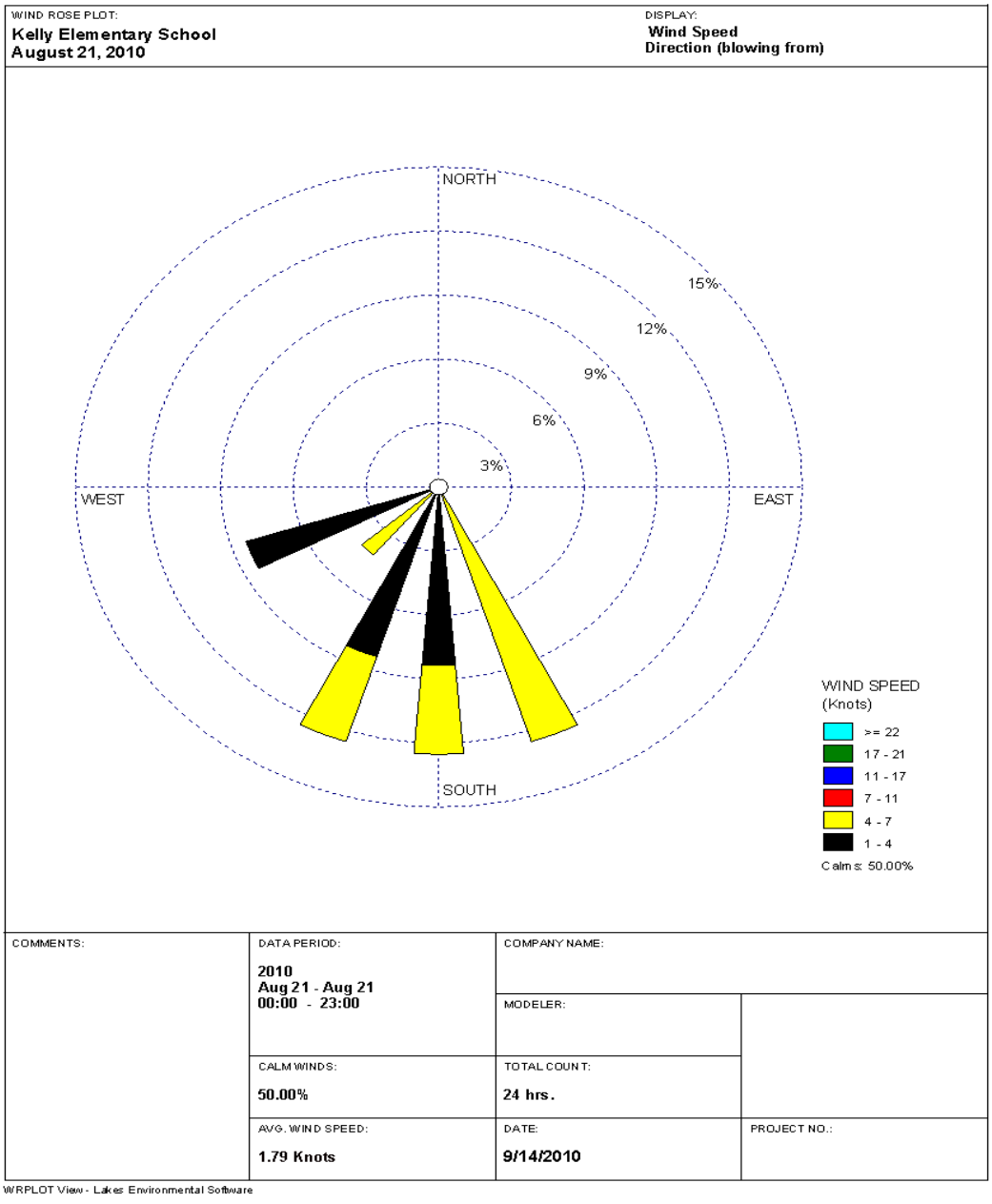

Figure 5: Wind rose for Kelly Elementary School, August 21, 2010.

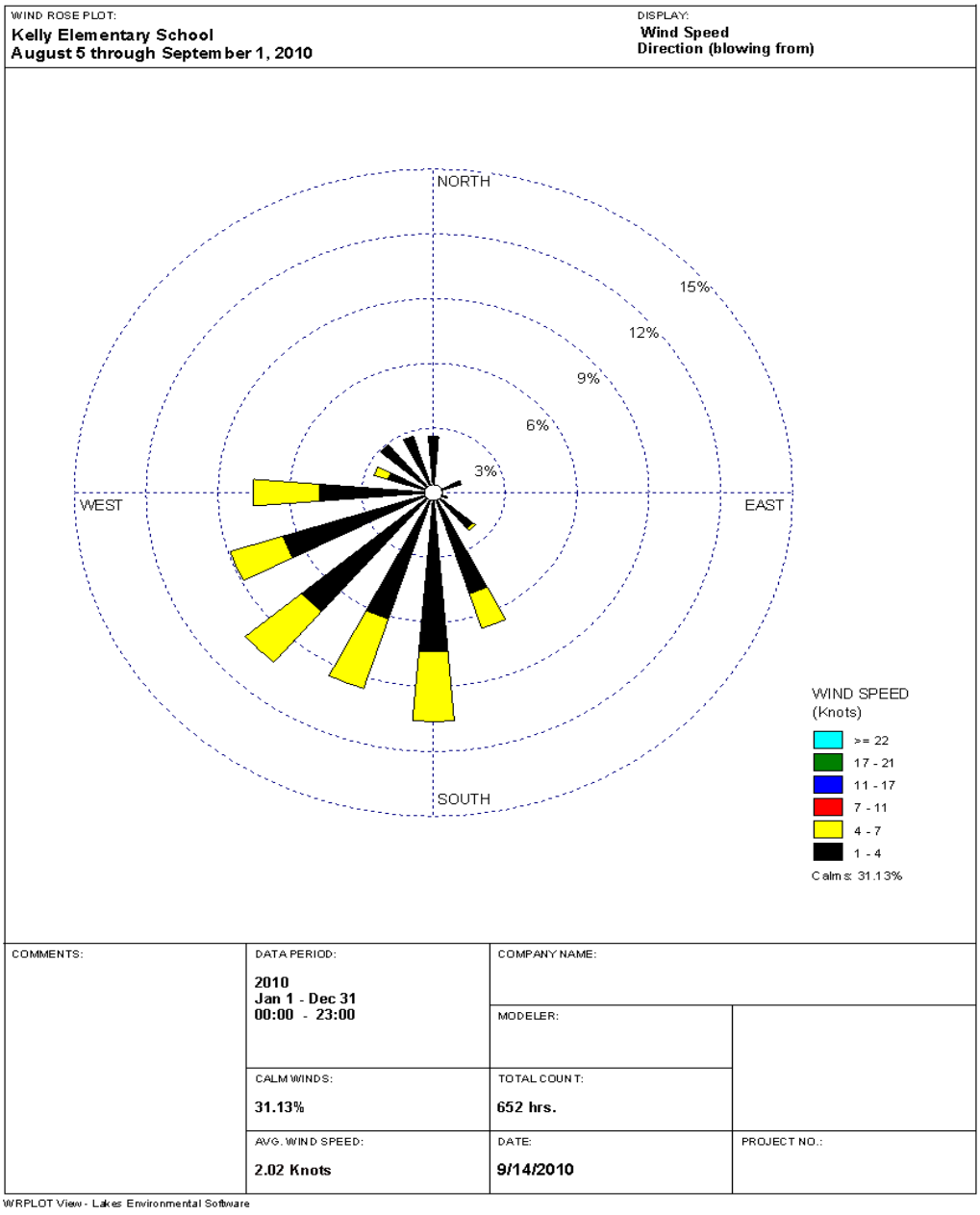

Figure 6: Wind rose for Kelly Elementary School, August 5 through September 1, 2010.

APPENDIX A

Volatile Organic Compounds

Benzene
1,3-Butadiene
Chlorobenzene
meta-Dichlorobenzene
ortho-Dichlorobenzene
para-Dichlorobenzene
Ethyl Benzene
Styrene
Toluene
meta/para-Xylene
Acrolein
Carbon Tetrachloride
Chloroform
cis-1,3-Dicloropropene
trans-1,3-Dicloropropene
Ethylene Dibromide
Ethylene Dichloride
Methyl Bromide
Methyl Chloroform
Methylene Chloride
Perchloroethylene
Trichloroethylene
ortho-Xylene
Methyl tertiary-Butyl Ether
Methyl Ethyl Ketone

Collection Method:
Xontech 910A/stainless steel canister

Laboratory Instrument:
Gas Chromatograph/
Mass Spectrometer

Toxic Volatile Carbonyl Compounds

Acetaldehyde
Formaldehyde
Acetone

Collection Method:
Xontech 920/adsorbent tube
KI scrubber

Laboratory Instrument:
High Performance Liquid Chromatograph

Toxic Metals

Antimony
Arsenic
Beryllium
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Manganese
Molybdenum
Nickel
Platinum
Selenium
Strontium
Sulfur
Tin
Titanium
Vanadium
Zinc
Zirconium

Collection Method:
Xontech 920/Teflon filter

Laboratory Instrument:
Inductively Coupled Plasma/
Mass Spectrometer

Table 1-Page 1: Toxics Volatile Organic Compounds (VOC)

	Sampling Area:	SW Playground	Duplicate	Escondido	SW Playground	Duplicate	Lunch Area
	SampleDay	8/12/2010	8/12/2010	8/12/2010	8/17/2010	8/17/2010	12:00 noon8/17/10
	Sample Times:	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59	12:00 noon 8/18/10
Target Compounds:	Units:	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)
1,3-butadiene		0.000	0.000	0.042	0.025	0.027	0.028
methyl bromide (bromomethane)		0.031	0.042	0.074	2.979	3.195	2.656
acrolein		0.206	0.229	0.132	0.173	0.179	0.072
acrylonitrile		0.008	0.000	0.000	0.000	0.000	0.000
methylene chloride		0.064	0.065	0.102	0.063	0.072	0.068
methyl tertiary butyl ether (MTBE)		0.019	0.017	0.018	0.000	0.011	0.000
methyl ethyl ketone (2-butanone)		0.265	0.302	0.241	0.275	0.259	0.185
chloroform		0.014	0.012	0.023	0.030	0.030	0.029
ethylene dichloride (1,2-dichloroethane)		0.008	0.008	0.011	0.013	0.015	0.014
methyl chloroform (1,1,1-trichloroethane)		0.013	0.011	0.012	0.023	0.024	0.023
carbon tetrachloride (tetrachloromethane)		0.091	0.089	0.089	0.100	0.105	0.101
benzene		0.059	0.063	0.142	0.077	0.078	0.082
trichloroethylene (trichloroethene)		0.015	0.014	0.017	0.000	0.000	0.000
cis-1,3-dichloropropene		0.000	0.000	0.000	0.000	0.000	0.000
trans-1,3-dichloropropene		0.000	0.000	0.000	0.000	0.000	0.000
toluene		0.105	0.108	0.331	0.241	0.244	0.196
ethylene dibromide (1,2-dibromoethane)		0.016	0.000	0.000	0.000	0.000	0.000
perchloroethylene (tetrachloroethene)		0.011	0.012	0.018	0.014	0.015	0.016
chlorobenzene		0.008	0.008	0.009	0.004	0.005	0.004
ethyl benzene		0.134	0.140	0.077	0.222	0.219	0.080
m,p-xylene		0.509	0.524	0.189	0.941	0.937	0.246
styrene		0.026	0.011	0.026	0.060	0.053	0.050
o-xylene		0.196	0.204	0.067	0.282	0.292	0.090
m-dichlorobenzene		0.019	0.019	0.018	0.029	0.029	0.029
p-dichlorobenzene		0.022	0.020	0.020	0.042	0.042	0.041
o-dichlorobenzene		0.037	0.036	0.000	0.022	0.022	0.022

Table 1-Page 2

	Sampling Area:	SW Playground	Duplicate	Lunch Area	SW Playground	Duplicate	Lunch Area
	SampleDay	8/19/2010	8/19/2010	8/19/2010	8/21/2010	8/21/2010	8/21/2010
	Sample Times:	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59
Target Compounds:	Units:	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)
1,3-butadiene		0.030	0.028	0.034	0.031	0.029	0.048
methyl bromide (bromomethane)		0.234	0.246	0.267	0.042	0.037	0.040
acrolein		0.181	0.118	0.160	0.155	0.079	0.115
acrylonitrile		0.000	0.000	0.000	0.000	0.000	0.000
methylene chloride		0.067	0.061	0.071	0.061	0.056	0.058
methyl tertiary butyl ether (MTBE)		0.000	0.000	0.022	0.000	0.023	0.023
methyl ethyl ketone (2-butanone)		0.296	0.246	0.326	0.217	0.144	0.193
chloroform		0.033	0.033	0.029	0.033	0.031	0.030
ethylene dichloride (1,2-dichloroethane)		0.010	0.009	0.008	0.010	0.009	0.010
methyl chloroform (1,1,1-trichloroethane)		0.017	0.018	0.017	0.017	0.017	0.017
carbon tetrachloride (tetrachloromethane)		0.086	0.089	0.086	0.093	0.084	0.088
benzene		0.095	0.097	0.099	0.080	0.075	0.093
trichloroethylene (trichloroethene)		0.000	0.000	0.019	0.000	0.000	0.000
cis-1,3-dichloropropene		0.000	0.000	0.000	0.000	0.000	0.000
trans-1,3-dichloropropene		0.000	0.000	0.000	0.000	0.000	0.000
toluene		0.190	0.168	0.232	0.157	0.135	0.185
ethylene dibromide (1,2-dibromoethane)		0.000	0.000	0.000	0.000	0.000	0.000
perchloroethylene (tetrachloroethene)		0.015	0.014	0.014	0.013	0.012	0.014
chlorobenzene		0.012	0.012	0.012	0.012	0.012	0.012
ethyl benzene		0.139	0.138	0.103	0.101	0.099	0.072
m,p-xylene		0.588	0.508	0.282	0.376	0.343	0.179
styrene		0.042	0.023	0.018	0.028	0.022	0.019
o-xylene		0.183	0.157	0.093	0.131	0.110	0.069
m-dichlorobenzene		0.014	0.014	0.015	0.014	0.013	0.013
p-dichlorobenzene		0.021	0.019	0.020	0.020	0.019	0.020
o-dichlorobenzene		0.035	0.035	0.035	0.035	0.000	0.034

Table 2: Comparison of VOC with other County Sites

	Kelly all sites	Kelly all sites	Kelly all sites	Chula Vista**	El Cajon**	San Diego Downtown*	Escondido*
	Minimum	Maximum	Average	2009 Average	2009 Average	2009 Average	2009 Average
Target Compounds:	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)
1,3-butadiene	0.000	0.048	0.025	0.064	0.073	0.067	0.093
methyl bromide (bromomethane)	0.031	3.195	0.888	0.016	0.015	0.013	0.013
acrolein	0.072	0.229	0.151	0.630	0.820	0.170	0.203
acrylonitrile	0.000	0.008	0.001	n/a	n/a	0.007	0.009
methylene chloride	0.056	0.072	0.064	0.100	0.130	0.144	0.128
methyl tertiary butyl ether (MTBE)	0.000	0.023	0.010	n/a	n/a	0.018	0.007
methyl ethyl ketone (2-butanone)	0.144	0.326	0.246	0.100	0.150	0.365	0.384
chloroform	0.012	0.033	0.028	0.033	0.033	0.027	0.034
ethylene dichloride (1,2-dichloroethane)	0.008	0.015	0.010	n/a	n/a	0.018	0.017
methyl chloroform (1,1,1-trichloroethane)	0.011	0.024	0.018	0.010	0.011	0.023	0.021
carbon tetrachloride (tetrachloromethane)	0.084	0.105	0.092	n/a	n/a	0.095	0.092
benzene	0.059	0.099	0.082	0.274	0.332	0.297	0.409
trichloroethylene (trichloroethene)	0.000	0.019	0.004	0.022	0.010	0.017	0.013
cis-1,3-dichloropropene	0.000	0.000	0.000	0.050	0.050	0.006	0.001
trans-1,3-dichloropropene	0.000	0.000	0.000	0.050	0.050	0.005	0.001
toluene	0.105	0.224	0.178	0.620	1.010	0.761	0.986
ethylene dibromide (1,2-dibromoethane)	0.000	0.016	0.001	n/a	n/a	0.007	0.003
perchloroethylene (tetrachloroethene)	0.011	0.018	0.014	0.021	0.116	0.024	0.024
chlorobenzene	0.004	0.012	0.009	n/a	n/a	0.010	0.008
ethyl benzene	0.072	0.222	0.132	0.120	0.150	0.124	0.157
m,p-xylene	0.179	0.941	0.494	0.320	0.490	0.398	0.532
styrene	0.011	0.060	0.032	0.050	0.060	0.057	0.071
o-xylene	0.069	0.292	0.164	0.120	0.180	0.147	0.197
m-dichlorobenzene	0.013	0.029	0.019	n/a	n/a	0.026	0.023
p-dichlorobenzene	0.019	0.042	0.026	n/a	n/a	0.040	0.042
o-dichlorobenzene	0.000	0.037	0.028	n/a	n/a	0.019	0.015

*Samples analyzed by State ARB

**Samples analyzed by APCD

n/a not analyzed (levels too low)

Table 3: Carbonyl Compounds

Sampling Area:	SW Playground	Lunch Area	SW Playground	Lunch Area
SampleDay	8/12/2010	8/12/2010	8/17/2010	12:00 noon 8/17/10-
Sample Times:	00:01-23:59	00:01-23:59	00:01-23:59	12:00 noon 8/18/10
Target Compounds: Units:	(ppbv)	(ppbv)	(ppbv)	(ppbv)
Formaldehyde	1.4	1.8	1.5	2.1
Acetaldehyde	0.5	0.4	0.7	0.5
Acetone	0.3	0.3	0.2	0.1

Sampling Area:	SW Playground	Lunch Area	SW Playground	Lunch Area
SampleDay	8/19/2010	8/19/2010	8/21/2010	8/21/2010
Sample Times:	00:01-23:59	00:01-23:59	00:01-23:59	00:01-23:59
Target Compounds: Units:	(ppbv)	(ppbv)	(ppbv)	(ppbv)
Formaldehyde	1.7	0.8	1.4	1.8
Acetaldehyde	0.7	0.2	0.5	0.5
Acetone	0.4	0.1	0.2	0.2

Table 4: Comparison of Carbonyl Compounds with other County Sites

	Kelly all sites*	Kelly all sites*	Kelly all sites*	Kearny Mesa*	El Cajon*	Chula Vista**	El Cajon**
	Minimum	Maximum	Average	2009 Average	2009 Average	2009 Average	2009 Average
Target Compounds:	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)	(ppbv)
Formaldehyde	0.8	2.1	1.6	2.3	2.6	1.8	2.6
Acetaldehyde	0.2	0.7	0.5	1.4	1.7	0.8	1.1
Acetone	0.1	0.4	0.2	4.6	5.2	11.2	11.0

*Samples analyzed by APCD

**Samples analyzed by State ARB

Table 5: Selected Metals

Metals:	Lunch Area	SW Playground	Lunch Area	SW Playground	Lunch Area	SW Playground	Lunch Area	SW Playground	Field Blank
	8/12/2010	8/12/2010	8/17/2010	8/17/2010	8/19/2010	8/19/2010	8/21/2010	8/21/2010	August, 2010
	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3	ng/m3
Antimony	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Arsenic	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Cadmium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chromium	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Cobalt	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Copper	1.5	4.5	4.6	3.9	5.3	5.6	2.4	2.3	<1.5
Iron	180	240	200	190	180	190	91	150	<30
Lead	3	3	2	3	2	3	<1.5	2	<1.5
Manganese	4	5	4	4	4	4	2	3	<1.5
Molybdenum	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Nickel	<9.0	17	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0
Platinum	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Strontium	4	4	4	4	5	6	4	5	<1.5
Sulfur	1000	1100	1300	1200	1300	1300	970	990	<60
Tin	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Titanium	<9.0	12	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0
Vanadium	2.1	2.4	2.7	2.7	7.1	7;4	2.8	2.9	<1.5
Zinc	18	21	16	16	19	22	18	18	<9
Zirconium	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

Table 6: Comparison of selected Metals with other County Sites

	Field Blank	Average for Kelly	Chula Vista	El Cajon
	August, 2010	August, 2010	2009 Average	2009 Average
Metals:	ng/m3	ng/m3	ng/m3	ng/m3
Antimony	<3.0	<3.0	<3.0	<3.0
Arsenic	<1.5	<1.5	0.8	0.8
Cadmium	<1.5	<1.5	0.8	0.8
Chromium	<3.0	<3.0	3.0	2.2
Cobalt	<1.5	<1.5	0.8	0.8
Copper	<1.5	3.8	<1.5	<1.5
Iron	<30	178	493	581
Lead	<1.5	**2**	<1.5	6.8
Manganese	<1.5	4	11	14
Molybdenum	<1.5	<1.5	0.8	0.8
Nickel	<9.0	<9.0	4.7	4.5
Platinum	<0.3	<0.3	<0.3	<0.3
Selenium	<1.5	<1.5	0.8	0.8
Strontium	<1.5	4	7.6	6.1
Sulfur	<60	1145	1110	893
Tin	<3.0	<3.0	2	1.5
Titanium	<9.0	<9.0	18	31
Vanadium	<1.5	3.2	<1.5	2.6
Zinc	<9	19	36	39
Zirconium	<1.5	<1.5	1.2	0.8