Bay Area Air Quality Management District

Updated Summary and Analysis of West Berkeley Air Monitoring Results

2009 Update

The Air District's West Berkeley Air Monitoring Station began operating on December 12, 2007. The sampling station is located approximately five blocks east of Interstate 80, near the northwest corner of 6th and Camelia streets (see Figure 1). After collecting data from 2008, Air District staff reviewed the data and developed a summary and analysis of the results, including estimates of risk. This report is an update that includes 2009 monitoring data and provides a comparison of 2009 data to 2008 data. This comparison indicates a general reduction in exposure to contaminants and reduced risk.

CRITERIA POLLUTANTS

Criteria pollutants are air contaminants for which the U.S. Environmental Protection Agency (EPA) and/or the California Air Resources Board (CARB) have adopted health-based ambient air quality standards. Ambient air quality standards adopted by EPA are National Ambient Air Quality Standards, and standards adopted by CARB are State Ambient Air Quality Standards. Criteria pollutants include PM_{10}, $PM_{2.5}$, ozone, carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and lead. Ozone, CO, SO_2, and NO_2 are gases. PM_{10} is particulate matter with a diameter less than or equal to 10 microns, and $PM_{2.5}$ is particulate matter with a diameter less than or equal to 2.5 microns. Lead is a component of particulate matter.

Table 1 summarizes West Berkeley monitoring results for all criteria pollutants for 2008 and 2009, provides a comparison to applicable National and State ambient air quality standards, and specifies locations with similar air quality.

GASES: Based on two years (2008 and 2009) of monitoring data, West Berkeley air quality levels were well below all applicable State and National Ambient Air Quality Standards (NAAQS) for gaseous criteria pollutants including ozone, CO, SO_2, and NO_2. West Berkeley CO and SO_2 levels were among the lowest for all Bay Area locations, while ozone levels were the lowest in the Bay Area. NO_2 levels were similar to, but somewhat lower than, levels at other urban locations. The primary source of NO_2 emissions in West Berkeley are vehicles on Interstate 80 and other roadways.

PARTICULATE MATTER: For both $PM_{2.5}$ and PM_{10}, there is a 24-hour ambient air quality standard based on daily concentrations, and an annual standard based on the average of all 24-hour concentrations over a one-year period. West Berkeley $PM_{2.5}$ levels exceeded the 24-hour NAAQS on two days in 2008 and on one day in 2009, but did not exceed the 24-hour PM_{10} NAAQS, with levels similar to Oakland. The annual average $PM_{2.5}$ and PM_{10} levels were below the NAAQS, but exceeded the more stringent annual average State standards, with levels similar to, but lower than, Napa.

LEAD: West Berkeley lead levels were less than 1% of the State standard, less than 10% of the recently revised national standard, and similar to levels in San Francisco.

Table 1. Criteria Pollutants Measured at the West Berkeley Monitoring Site Compared to State and National Ambient Air Quality Standards

Pollutant	Averaging Time	State Standard	National Standard	2008 West Berkeley Concentrations	2009 West Berkeley Concentrations	Location(s) with Similar Air Quality
Ozone	1 Hour	0.09 ppm	N/A	0.053 ppm	0.063 ppm	Lowest in the Bay Area
	8 Hour	0.070 ppm	0.075 ppm	0.049 ppm	0.054 ppm	
PM_{10}	24 Hour	50 $\mu g/m^3$	150 $\mu g/m^3$	44 $\mu g/m^3$	31 $\mu g/m^3$	San Francisco, Napa
	Annual Average	20 $\mu g/m^3$	N/A	22.5 $\mu g/m^3$	17.2 $\mu g/m^3$	
$PM_{2.5}$*	24 Hour	N/A	35 $\mu g/m^3$	39 $\mu g/m^3$	40 $\mu g/m^3$	Oakland
	Annual Average	12 $\mu g/m^3$	15.0 $\mu g/m^3$	12.9 $\mu g/m^3$	9.9 $\mu g/m^3$	Napa
CO	8 Hour	9.0 ppm	9 ppm	1.7 ppm	2.0 ppm	Pittsburg, Oakland
	1 Hour	20 ppm	35 ppm	2.8 ppm	2.8 ppm	
NO_2	Annual Average	0.030 ppm	0.053 ppm	0.014 ppm	0.013 ppm	San Francisco, San Jose
	1 Hour	0.18 ppm	0.100 ppm	0.055 ppm	0.050 ppm	
SO_2	Annual Average	N/A	0.030 ppm	0.0013 ppm	0.0013 ppm	Among the lowest in the Bay Area
	24 Hour	0.04 ppm	0.14 ppm	0.004 ppm	0.004 ppm	
	1 Hour	0.25 ppm	N/A	0.014 ppm	0.016 ppm	
Lead**	30 Day Average	1.5 $\mu g/m^3$	N/A	0.011 $\mu g/m^3$	0.012 $\mu g/m^3$	San Francisco
	3 Month Average	N/A	0.15 $\mu g/m^3$	0.009 $\mu g/m^3$	0.008 $\mu g/m^3$	

Note: West Berkeley concentrations listed are maximum values recorded for the 1-hr, 8-hr, 24-hr, 30 day, and 3-month averaging periods.

* As measured by continuous $PM_{2.5}$ monitors.

** As measured by a XonTec 924 sampler.

TOXIC AIR CONTAMINANTS

Table 2 summarizes 2008 and 2009 toxic air contaminant monitoring results for West Berkeley, and provides comparisons to several other sites in the Bay Area and in the South Coast AQMD (North Long Beach and Rubidoux). Samples are collected over 24-hours for either a 6-day or 12-day interval schedule. Table 2 indicates the maximum concentrations for the 24-hour samples, and also all samples averaged over a 1-year period.

Air District staff estimated health risks using the 2008 ambient monitoring data and health effect values [i.e., cancer potency factors and noncancer Reference Exposure Levels (RELs)] established by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA). Four health risk summary tables are provided as follows: cancer risk, chronic non-cancer risk, 8-hour chronic non-cancer risk, and acute non-cancer risk. Note that each health risk summary table lists only the measured toxic air contaminant compounds for which a corresponding cancer or non-cancer health effect value has been adopted by OEHHA. Health risks were based on the following exposure pathways, where applicable, under OEHHA health risk assessment guidelines: inhalation, dermal absorption, soil ingestion, mother's milk ingestion, and homegrown produce ingestion. Non-inhalation pathway exposures were estimated based on measured pollutant concentrations and conservative default exposure assumptions established in OEHHA guidelines.

Four associated tables compare 2009 risk to 2008 risk in West Berkeley and indicate a reduction in exposure to toxic air contaminants and reduced risk.

Table 3 lists the estimated cancer risk associated with lifetime exposure to the measured levels of toxic air contaminants based on monitoring results from 2008. The total cancer risk is based on the sum of the cancer risks determined for each individual compound. Total cancer risk based on the monitoring results in West Berkeley is somewhat greater than the risk in Benicia, similar to the risk in San Francisco, and significantly less than risk in San Jose, North Long Beach and Rubidoux. A comparison of cancer risk at the different monitoring sites is illustrated in Figure 2. The compounds that contribute most significantly to cancer risk in West Berkeley are diesel PM, benzene, 1,3-butadiene, and carbon tetrachloride. This is consistent with other monitoring sites. These pollutants are emitted primarily from mobile sources, with the exception of carbon tetrachloride. There are no known local sources of carbon tetrachloride due to the phase-out of this compound as a stratospheric ozone-depleting compound. Measured levels of carbon tetrachloride in West Berkeley are consistent with global background levels observed at other monitoring sites.

Table 3A illustrates the comparison of cancer risk based on monitoring results in West Berkeley from 2008 and 2009. Cancer risk is approximately 11% lower using 2009 data compared to 2008 data, primarily because of reduced concentrations of diesel PM and benzene. District staff has also incorporated use of an Age Sensitivity Factor to calculate residential cancer risk in order to account for inherent increased susceptibility to carcinogens during infancy and childhood (adopted by OEHHA in June 2009).

Table 4 indicates the estimated chronic non-cancer risk (represented by hazard quotients and hazard index) for 2008 monitoring data. A hazard quotient is the ratio of the observed concentration of a particular compound to the compound's REL. RELs are concentrations at or below which no adverse non-cancer health effects are anticipated to occur in the general human population, including sensitive individuals. The hazard index is taken as the sum of the hazard quotients for each compound that affects the same target organ system (e.g., respiratory system, nervous system, etc.). A hazard index at or below one indicates that no adverse effects would be anticipated to occur. The chronic hazard index is less than one for West Berkeley, the other Bay Area comparator sites, and for the North Long Beach site. The hazard index is greater than one for Rubidoux. A comparison of chronic noncancer risk at the different monitoring sites is illustrated in Figure 3.

Table 4A illustrates the comparison of chronic non-cancer risk based on monitoring results in West Berkeley from 2008 and 2009. The chronic hazard index for 2009 is 0.51, which is 23% lower than the chronic hazard index for 2008 (0.66), primarily because of reduced concentrations of formaldehyde. These results (hazard index less than one) indicate that non-cancer adverse effects would not be expected from chronic exposure to toxic air contaminants.

Table 5 lists the estimated 8-hour chronic non-cancer risk based on 2008 monitoring results. The 8-hour hazard indices are based on concentrations for the normal 8-hour exposure period for workers, and for children at schools and daycare facilities, that are repeated over an annual period. Note that 8-hour monitoring data are not available, but these concentrations were conservatively estimated by assuming that the entire 24-hour sample was collected over a single 8-hour period (i.e., 8-hour concentrations were assumed to be three times the measured 24-hour concentration). The 8-hour chronic hazard index is less than one for West Berkeley, the other Bay Area comparator sites, and for the North Long Beach site. The 8-hour chronic hazard index is greater than one for Rubidoux. A comparison of 8-hour non-cancer risk at the different monitoring sites is illustrated in Figure 4.

Table 5A illustrates the comparison of the estimated 8-hour chronic non-cancer risks based on monitoring results in West Berkeley from 2008 and 2009. The 8-hour chronic hazard index for 2009 is 0.58 which is 11% lower than the 8-hour chronic hazard index for 2008 (0.65), primarily because of reduced concentrations of manganese. These results (hazard index less than one) indicate that non-cancer adverse effects would not be expected for workers or children exposed at these concentrations for 8 hours a day on an extended basis.

Table 6 lists the estimated acute non-cancer risk based on monitoring data from 2008. The acute hazard indices are based on maximum concentrations for a 1-hour period. Note that 1-hour monitoring data are not available, but these concentrations were conservatively assumed to be 7.5 times the maximum 24-hour concentration (see table footnote for derivation of this adjustment factor). The acute hazard index is less than one for West Berkeley, the other Bay Area comparator sites, and for the North Long Beach site. The acute hazard index is greater than one for Rubidoux. A comparison of acute non-cancer risk at the different monitoring sites is illustrated in Figure 5.

Table 6A illustrates the comparison of acute non-cancer risk based on monitoring results in West Berkeley from 2008 and 2009. The acute hazard index for 2009 is 0.27, which is 52% lower than the acute hazard index for 2008 (0.56); primarily because of reduced concentrations of formaldehyde. These results (hazard index less than one) indicate that non-cancer adverse effects would not be expected from acute exposure to toxic air contaminants.

Table 2. Summary of 2008/2009 Toxic Air Contaminant Ambient Air Monitoring Data in Bay Area and South Coast AQMD

		Berkeley ($\mu g/m^3$)	Benicia ($\mu g/m^3$)	San Francisco ($\mu g/m^3$)	San Jose ($\mu g/m^3$)	Rubidoux ($\mu g/m^3$)	N Long Beach ($\mu g/m^3$)
Elemental Carbon	2008 annual avg.	0.926	0.655	1.020	1.320	1.640	1.500
	2009 annual avg.	0.840	n/a	0.784	1.026	1.640	1.500
Diesel PM	2008 annual avg.	0.963	0.681	1.061	1.373	1.706	1.560
	2009 annual avg.	0.874	n/a	0.815	1.07	1.706	1.560
Manganese	2008 annual avg.	0.037	0.009	0.009	0.010	0.043	0.019
	2008 max 24-hr	0.170	0.170	0.036	0.031	0.110	0.060
	2009 annual avg.	0.033	0.009	0.006	0.007	0.029	0.016
	2009 max 24-hr	0.170	0.170	0.015	0.022	0.050	0.040
Chromium (Total)	2008 annual avg.	0.005	0.005	0.004	0.003	0.005	0.005
	2008 max 24-hr	0.029	0.085	0.008	0.006	0.010	0.012
	2009 annual avg.	0.005	0.005	0.002	0.004	0.0038	0.005
	2009 max 24-hr	0.029	0.085	0.004	0.005	0.006	0.040
Lead	2008 annual avg.	0.007	0.005	0.007	0.010	0.010	0.009
	2008 max 24-hr	0.018	0.025	0.017	0.050	0.060	0.030
	2009 annual avg.	0.007	0.005	0.005	0.004	0.008	0.008
	2009 max 24-hr	0.023	0.025	0.01	0.01	0.02	0.016
Nickel	2008 annual avg.	0.014	0.007	0.006	0.007	0.012	0.009
	2008 max 24-hr	0.071	0.100	0.019	0.029	0.029	0.027
	2009 annual avg.	0.012	0.007	0.005	0.006	0.005	0.005
	2009 max 24-hr	0.071	0.100	0.005	0.036	0.010	0.010
1-3 Butadiene	2008 annual avg.	0.082	0.062	0.062	0.117	0.131	0.207
	2008 max 24-hr	0.281	0.224	0.168	0.561	0.314	0.808
	2009 annual avg.	0.093	n/a	0.086	0.112	0.11	0.22
	2009 max 24-hr	0.332	n/a	0.398	0.553	0.76	0.74
Acetaldehyde	2008 annual avg.	1.061	0.850	0.594	1.792	2.642	1.417
	2008 max 24-hr	3.383	2.468	1.646	4.845	8.594	4.206
	2009 annual avg.	0.964	n/a	3.750	1.630	2.2	1.3
	2009 max 24-hr	2.793	n/a	10.09	4.234	6.0	3.5

Table 2. Summary of 2008/2009 Toxic Air Contaminant Ambient Air Monitoring Data in Bay Area and South Coast AQMD
(Continued)

		Berkeley ($\mu g/m^3$)	Benicia ($\mu g/m^3$)	San Francisco ($\mu g/m^3$)	San Jose ($\mu g/m^3$)	Rubidoux ($\mu g/m^3$)	N Long Beach ($\mu g/m^3$)
Benzene	2008 annual avg.	0.875	0.344	0.567	0.998	1.039	1.426
	2008 max 24-hr	3.241	1.134	1.329	3.598	2.431	4.862
	2009 annual avg.	0.531	n/a	0.576	0.728	0.88	1.4
	2009 max 24-hr	1.917	n/a	1.310	3.642	3.6	3.2
Carbon tetrachloride	2008 annual avg.	0.604	0.598	0.611	0.617	0.610	0.610
	2008 max 24-hr	0.763	0.763	0.827	0.827	0.800	0.800
	2009 annual avg.	0.579	n/a	0.623	0.573	n/a	n/a
	2009 max 24-hr	0.818	n/a	0.818	0.755	n/a	n/a
Formaldehyde	2008 annual avg.	1.645	1.296	1.147	2.530	4.748	2.754
	2008 max 24-hr	3.739	4.486	2.991	6.231	10.842	5.110
	2009 annual avg.	0.755	n/a	0.786	1.075	3.9	2.6
	2009 max 24-hr	1.719	n/a	2.763	2.763	9.8	5.9
Tetrachloroethylene	2008 annual avg.	0.138	0.031	0.141	0.444	0.162	0.341
	2008 max 24-hr	0.413	0.103	0.447	6.435	0.344	3.441
	2009 annual avg.	0.068	n/a	0.125	0.207	0.14	0.28
	2009 max 24-hr	0.407	n/a	0.475	1.051	1.4	0.96
Trichloroethylene	2008 annual avg.	0.041	0.035	0.038	0.079	0.063	0.106
	2008 max 24-hr	0.218	0.164	0.109	0.218	0.164	0.273
	2009 annual avg.	0.027	n/a	0.027	0.059	0.055	0.082
	2009 max 24-hr	0.054	n/a	0.054	0.215	0.16	0.22

1. Concentrations represent ambient air samples collected in 2008, except for some diesel PM, lead and nickel samples as described below.
2. Diesel PM is estimated from elemental carbon data using MATES II factor of 1.04. Elemental carbon data for Rubidoux & N Long Beach are from 2004-2006
3. Some data for lead and nickel are for samples collected in 2007 for San Francisco, San Jose, Rubidoux & North Long Beach.
4. Data (2008) for carbon tetrachloride are not available for Rubidoux & North Long Beach; values represent average of Bay Area sites, which are consistent with global background levels.

Table 3. Cancer Risk Based on 2008 Ambient Air Monitoring Data in Bay Area & South Coast AQMD

		Berkeley	**Benicia**	**San Francisco**	**San Jose**	**Rubidoux**	**N Long Beach**
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)
Diesel PM	annual avg.	0.963	0.681	1.061	1.373	1.706	1.560
Lead	annual avg.	0.007	0.005	0.007	0.010	0.010	0.009
Nickel	annual avg.	0.014	0.007	0.006	0.007	0.012	0.009
1-3 Butadiene	annual avg.	0.082	0.062	0.062	0.117	0.131	0.207
Acetaldehyde	annual avg.	1.061	0.850	0.594	1.792	2.642	1.417
Benzene	annual avg.	0.875	0.344	0.567	0.998	1.039	1.426
Carbon tetrachloride	annual avg.	0.604	0.598	0.611	0.617	0.610	0.610
Formaldehyde	annual avg.	1.645	1.296	1.147	2.530	4.748	2.754
Tetrachloroethylene	annual avg.	0.138	0.031	0.141	0.444	0.162	0.341
Trichloroethylene	annual avg.	0.041	0.035	0.038	0.079	0.063	0.106

	URF	**Berkeley**	**Benicia**	**San Francisco**	**San Jose**	**Rubidoux**	**N Long Beach**
	$(\mu g/m^3)^{-1}$	Cancer risk (in a million)	Cancer risk (in a million)	Cancer risk (in a million)	Cancer risk (in a million)	Cancer risk (in a million)	Cancer risk (in a million)
Diesel PM	0.0003000	288.9	204.4	318.2	411.8	511.7	468.0
Lead	0.0000509	0.4	0.2	0.4	0.5	0.5	0.4
Nickel	0.0002640	3.6	1.9	1.7	1.9	3.1	2.3
1-3 Butadiene	0.0001700	13.9	10.5	10.5	19.9	22.2	35.1
Acetaldehyde	0.0000027	2.9	2.3	1.6	4.8	7.1	3.8
Benzene	0.0000290	25.4	10.0	16.4	28.9	30.1	41.4
Carbon tetrachloride	0.0000420	25.4	25.1	25.6	25.9	25.0	25.0
Formaldehyde	0.0000060	9.9	7.8	6.9	15.2	28.5	16.5
Tetrachloroethylene	0.0000059	0.8	0.2	0.8	2.6	1.0	2.0
Trichloroethylene	0.0000020	0.1	0.1	0.1	0.2	0.1	0.2
Total Cancer risk		**371**	**262**	**382**	**512**	**629**	**595**

1. Unit Risk Factors (URFs) for diesel PM and VOCs are for inhalation pathway only.
2. URFs were adjusted where applicable for inhalation & noninhalation pathways (dermal, soil ingestion, mother's milk, homegrown produce ingestion) using cancer potency factors & HARP default exposure factors.
3. Lifetime residential cancer risk is estimated assuming potential exposure occurs 24 hours per day, 350 days/year, over a 70-year lifetime.

Table 3A. Comparison of Cancer Risk Based on 2008 & 2009 Ambient Air Monitoring Data in West Berkeley

		2008 ($\mu g/m^3$)	2009 ($\mu g/m^3$)
Diesel PM	annual avg.	0.963	0.874
Lead	annual avg.	0.007	0.007
Nickel	annual avg.	0.014	0.012
1-3 Butadiene	annual avg.	0.082	0.093
Acetaldehyde	annual avg.	1.061	0.964
Benzene	annual avg.	0.875	0.531
Carbon tetrachloride	annual avg.	0.604	0.579
Formaldehyde	annual avg.	1.645	0.755
Tetrachloroethylene	annual avg.	0.138	0.068
Trichloroethylene	annual avg.	0.041	0.027

	URF $(\mu g/m^3)^{-1}$	Cancer risk (in a million)	Cancer risk (in a million)
Diesel PM	0.0003000	288.9	262.2
Lead	0.0000509	0.4	0.4
Nickel	0.0002640	3.6	3.2
1-3 Butadiene	0.0001700	13.9	15.8
Acetaldehyde	0.0000027	2.9	2.6
Benzene	0.0000290	25.4	15.4
Carbon tetrachloride	0.0000420	25.4	24.3
Formaldehyde	0.0000060	9.9	4.5
Tetrachloroethylene	0.0000059	0.8	0.4
Trichloroethylene	0.0000020	0.1	0.1
Unadjusted Residential Cancer Risk		**371**	**329**
Age Sensitivity Factor		**1.7**	**1.7**
Adjusted Residential Cancer Risk		**631**	**559**

1. See notes for Table 3.
2. Age Sensitivity Factor is used to calculate residential cancer risk in order to account for inherent increased susceptibility to carcinogens during infancy and childhood (adopted by OEHHA in June 2009).

Table 4. Chronic Non-Cancer Risk Based on 2008 Ambient Air Monitoring Data in Bay Area and South Coast AQMD

		Berkeley	Benicia	San Francisco	San Jose	Rubidoux	N Long Beach	Chronic REL
		(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)
Manganese	annual avg.	0.037	0.009	0.009	0.010	0.043	0.019	0.090
Diesel PM	annual avg.	0.963	0.681	1.061	1.373	1.706	1.560	5
Nickel	annual avg.	0.014	0.007	0.006	0.007	0.012	0.009	0.050
Acetaldehyde	annual avg.	1.061	0.850	0.594	1.792	2.642	1.417	140
Formaldehyde	annual avg.	1.645	1.296	1.147	2.530	4.748	2.754	9
1-3 Butadiene	annual avg.	0.082	0.062	0.062	0.117	0.131	0.207	20
Benzene	annual avg.	0.875	0.344	0.567	0.998	1.039	1.426	60
Carbon tetrachloride	annual avg.	0.604	0.598	0.611	0.617	0.610	0.610	40
Tetrachloroethylene	annual avg.	0.138	0.031	0.141	0.444	0.162	0.341	35

		Berkeley	Benicia	San Francisco	San Jose	Rubidoux	N Long Beach	target organ system
Manganese	Hazard Quotient	0.411	0.097	0.102	0.109	0.476	0.208	nervous
Diesel PM	Hazard Quotient	0.193	0.136	0.212	0.275	0.341	0.312	respiratory
Nickel	Hazard Quotient	0.280	0.140	0.12	0.14	0.240	0.180	respiratory, blood
Acetaldehyde	Hazard Quotient	0.008	0.006	0.004	0.013	0.019	0.010	respiratory
Formaldehyde	Hazard Quotient	0.183	0.144	0.127	0.281	0.528	0.306	respiratory
1-3 Butadiene	Hazard Quotient	0.004	0.003	0.003	0.006	0.007	0.010	reproductive
Benzene	Hazard Quotient	0.015	0.006	0.009	0.017	0.017	0.024	blood, nervous, development
Carbon tetrachloride	Hazard Quotient	0.015	0.015	0.015	0.015	0.015	0.015	alimentary, nervous, development
Tetrachloroethylene	Hazard Quotient	0.004	0.001	0.004	0.013	0.005	0.010	kidney, alimentary, liver
CHRONIC HAZARD INDEX		**0.66**	**0.43**	**0.47**	**0.71**	**1.12**	**0.81**	HI for respiratory system

1. A chronic inhalation hazard quotient (HQ) is the ratio of the annual average concentration to the chronic inhalation REL. A noninhalation HQ is the ratio of the estimated non-inhalation dose to the oral REL. The HQ for each compound is the sum of the chemical specific inhalation HQ and non-inhalation HQ. For these compounds, only nickel has an established chronic oral REL, but the non-inhalation pathway was not significant.
2. A Hazard Index (HI) is the sum of the hazard quotients (HQ) for all compounds that affect a particular target organ system. The highest target organ specific HI is the overall HI.
3. Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur; rather, it is an indication of the erosion of the margin of safety, and an increased likelihood that adverse health effects will occur.

Table 4A. Comparison of Chronic Non-Cancer Risk Based on 2008 & 2009 Ambient Air Monitoring Data in West Berkeley

		2008	2009	Chronic REL
		(μg/m^3)	(μg/m^3)	(μg/m^3)
Manganese	annual avg.	0.037	0.033	0.090
Diesel PM	annual avg.	0.963	0.874	5
Nickel	annual avg.	0.014	0.012	0.050
Acetaldehyde	annual avg.	1.061	0.964	140
Formaldehyde	annual avg.	1.645	0.755	9
1-3 Butadiene	annual avg.	0.082	0.093	20
Benzene	annual avg.	0.875	0.531	60
Carbon tetrachloride	annual avg.	0.604	0.579	40
Tetrachloroethylene	annual avg.	0.138	0.068	35
				target organ system
Manganese	Hazard Quotient	0.411	0.367	nervous
Diesel PM	Hazard Quotient	0.193	0.175	respiratory
Nickel	Hazard Quotient	0.280	0.240	respiratory, blood
Acetaldehyde	Hazard Quotient	0.008	0.007	respiratory
Formaldehyde	Hazard Quotient	0.183	0.084	respiratory
1-3 Butadiene	Hazard Quotient	0.004	0.005	reproductive
Benzene	Hazard Quotient	0.015	0.009	blood, nervous, development
Carbon tetrachloride	Hazard Quotient	0.015	0.014	alimentary, nervous, development
Tetrachloroethylene	Hazard Quotient	0.004	0.002	kidney, alimentary, liver
CHRONIC HAZARD INDEX		**0.44**	**0.39**	HI for nervous system
CHRONIC HAZARD INDEX		**0.66**	**0.51**	HI for respiratory system

1. See notes for Table 4.

Table 5. 8-hour Chronic Non-Cancer Risk Based on 2008 Ambient Air Monitoring Data in Bay Area & South Coast AQMD

		Berkeley ($\mu g/m^3$)	Benicia ($\mu g/m^3$)	San Francisco ($\mu g/m^3$)	San Jose ($\mu g/m^3$)	Rubidoux ($\mu g/m^3$)	N Long Beach ($\mu g/m^3$)	8-hr REL ($\mu g/m^3$)
Manganese	annual avg.	0.037	0.009	0.009	0.010	0.043	0.019	
Manganese	est. 8-hr avg.	0.111	0.026	0.028	0.029	0.128	0.056	0.17
Acetaldehyde	annual avg.	1.061	0.850	0.594	1.792	2.642	1.417	
Acetaldehyde	est. 8-hr avg.	3.182	2.551	1.783	5.376	7.927	4.251	300
Formaldehyde	annual avg.	1.645	1.296	1.147	2.530	4.748	2.754	
Formaldehyde	est. 8-hr avg.	4.935	3.888	3.440	7.590	14.245	8.263	9

		Berkeley	Benicia	San Francisco	San Jose	Rubidoux	N Long Beach	target organ system
Manganese	8-hr HQ	0.653	0.154	0.162	0.173	0.755	0.330	nervous
Nervous System Hazard Index		**0.653**	**0.154**	**0.162**	**0.173**	**0.755**	**0.330**	**nervous**
Acetaldehyde	8-hr HQ	0.011	0.009	0.006	0.018	0.026	0.014	respiratory
Formaldehyde	8-hr HQ	0.548	0.432	0.382	0.843	1.583	0.918	respiratory
Respiratory System Hazard Index		**0.559**	**0.441**	**0.388**	**0.861**	**1.609**	**0.932**	**respiratory**
8-HOUR Hazard Index		**0.65**	**0.44**	**0.39**	**0.86**	**1.60**	**0.93**	

1. In order to estimate maximum 8-hour chronic exposure, it was conservatively assumed that all the pollutants for a 24-hour sample were collected within an 8-hour period. Therefore, an adjustment factor of 3 (24 hr/8 hr) was applied to the annual average concentrations (averages of multiple 24-hr samples).
2. An 8-hr hazard quotient (HQ) is calculated by dividing the 8-hour average concentration (e.g., for a worker or student or child at daycare that is repeated over an annual period) by the 8-hr REL.
3. A Hazard Index (HI) is the sum of hazard quotients for all compounds that affect a particular target organ system. The greatest target organ specific HI is the overall HI.
4 Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur; rather, it is an indication of the erosion of the margin of safety, and an increased likelihood that adverse health effects will occur.

Table 5A. Comparison of 8-hour Chronic Non-Cancer Risk Based on 2008 & 2009 Ambient Air Monitoring Data in West Berkeley

		2008 ($\mu g/m^3$)	**2009** ($\mu g/m^3$)	**8-hr REL** ($\mu g/m^3$)
Manganese	annual avg.	0.037	0.033	
Manganese	est. 8-hr avg.	0.111	0.099	0.17
Acetaldehyde	annual avg.	1.061	0.964	
Acetaldehyde	est. 8-hr avg.	3.182	2.892	300
Formaldehyde	annual avg.	1.645	0.755	
Formaldehyde	est. 8-hr avg.	4.935	2.265	9

		2008	**2009**	**target organ system**
Manganese	8-hr HQ	0.653	0.582	nervous
Nervous System Hazard Index		**0.653**	**0.582**	**nervous**
Acetaldehyde	8-hr HQ	0.011	0.010	respiratory
Formaldehyde	8-hr HQ	0.548	0.252	respiratory
Respiratory System Hazard Index		**0.559**	**0.262**	**respiratory**

8-HOUR Hazard Index	**0.65**	**0.58**

1. See notes for Table 5.

Table 6. Acute Non-Cancer Risk Based on 2008 Ambient Air Monitoring Data in Bay Area and South Coast AQMD

		Berkeley ($\mu g/m^3$)	Benicia ($\mu g/m^3$)	San Francisco ($\mu g/m^3$)	San Jose ($\mu g/m^3$)	Rubidoux ($\mu g/m^3$)	N Long Beach ($\mu g/m^3$)	Acute REL ($\mu g/m^3$, 1-hr avg.)
Nickel	max 24-hr	0.071	0.100	0.019	0.029	0.029	0.027	
Nickel	est. 1-hr avg.	0.533	0.750	0.143	0.218	0.218	0.203	6
Acetaldehyde	max 24-hr	3.383	2.468	1.646	4.845	8.594	4.206	
Acetaldehyde	est. 1-hr avg.	25.370	18.513	12.342	36.341	64.454	31.541	470
Benzene	max 24-hr	3.241	1.134	1.329	3.598	2.431	4.862	
Benzene	est. 1-hr avg.	24.309	8.508	9.967	26.983	18.231	36.463	1300
Formaldehyde	max 24-hr	3.739	4.486	2.991	6.231	10.842	5.110	
Formaldehyde	est. 1-hr avg.	28.041	33.649	22.432	46.734	81.317	38.322	55
Tetrachloroethylene	max 24-hr	0.413	0.103	0.447	6.435	0.344	3.441	
Tetrachloroethylene	est. 1-hr avg.	3.097	0.774	3.355	48.260	2.581	25.807	20,000
Carbon tetrachloride	max 24-hr	0.763	0.763	0.827	0.827	0.800	0.800	
Carbon tetrachloride	est. 1-hr avg.	5.724	5.724	6.200	6.200	6.000	6.000	1900

		Berkeley	Benicia	San Francisco	San Jose	Rubidoux	N Long Beach	target organ system
Nickel	Acute HQ	0.089	0.125	0.024	0.036	0.036	0.034	respiratory, immune
Acetaldehyde	Acute HQ	0.054	0.039	0.026	0.077	0.137	0.067	sensory irritation: bronchi, eyes, nose, throat
Benzene	Acute HQ	0.019	0.007	0.008	0.021	0.014	0.028	reproductive, development
Formaldehyde	Acute HQ	0.510	0.612	0.408	0.850	1.478	0.697	sensory irritation: eyes
Tetrachloroethylene	Acute HQ	0.00015	0.00004	0.00017	0.00241	0.00013	0.00129	nervous, respiratory, eyes
Carbon tetrachloride	Acute HQ	0.003	0.003	0.003	0.003	0.003	0.003	reproductive, development
Acute Hazard Index		**0.56**	**0.65**	**0.43**	**0.93**	**1.62**	**0.77**	**sensory irritation: eyes**

1. An acute hazard quotient is the value of the maximum 1-hour average concentration divided by the acute REL.
2. A hazard Index (HI) is the sum of the hazard quotients (HQ) for all compounds that affect a particular target organ system. The greatest target organ specific HI is the overall HI.
3. Adverse health effects are not expected to occur, even for sensitive members of the population, for hazard indices less than one. An exceedance of one does not indicate that adverse effects will occur; rather, it is an indication of the erosion of the margin of safety, and an increased likelihood that adverse health effects will occur
4. Max. 1-hr concentrations were assumed to be 7.5 times the max. 24-hr concentration. This adjustment factor was determined by multiplying a 1-hr to 24-hr meteorological persistence factor of 1 / 0.4 = 2.5 ("Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992, EPA-454/R-92-019, page 4-16), by an emission rate scalar of 3 (24 hr/8 hr), that accounts for temporal differences in emissions over the 24-hour period.

Table 6A. Comparison of Acute Non-Cancer Risk Based on 2008 & 2009 Ambient Air Monitoring Data in West Berkeley

		2008 ($\mu g/m^3$)	**2009** ($\mu g/m^3$)	**Acute REL** ($\mu g/m^3$, 1-hr avg.)
Nickel	max 24-hr	0.071	0.071	
Nickel	est. 1-hr avg.	0.533	0.533	6
Acetaldehyde	max 24-hr	3.383	2.793	
Acetaldehyde	est. 1-hr avg.	25.370	20.945	470
Benzene	max 24-hr	3.241	1.917	
Benzene	est. 1-hr avg.	24.309	14.378	1300
Formaldehyde	max 24-hr	3.739	1.719	
Formaldehyde	est. 1-hr avg.	28.041	12.892	55
Tetrachloroethylene	max 24-hr	0.413	0.407	
Tetrachloroethylene	est. 1-hr avg.	3.097	3.052	20,000
Carbon tetrachloride	max 24-hr	0.763	0.818	
Carbon tetrachloride	est. 1-hr avg.	5.724	6.137	1900
				target organ system
Nickel	Acute HQ	0.089	0.089	respiratory, immune
Acetaldehyde	Acute HQ	0.054	0.045	sensory irritation: bronchi, eyes, nose, throat
Benzene	Acute HQ	0.019	0.011	reproductive, development
Formaldehyde	Acute HQ	0.510	0.234	sensory irritation: eyes
Tetrachloroethylene	Acute HQ	0.00015	0.00015	nervous, respiratory, eyes
Carbon tetrachloride	Acute HQ	0.003	0.003	reproductive, development
Acute Hazard Index		**0.56**	**0.27**	**sensory irritation: eyes**

1. See notes for Table 6.

Figure 1. Location of the Air District's West Berkeley Air Monitoring Station

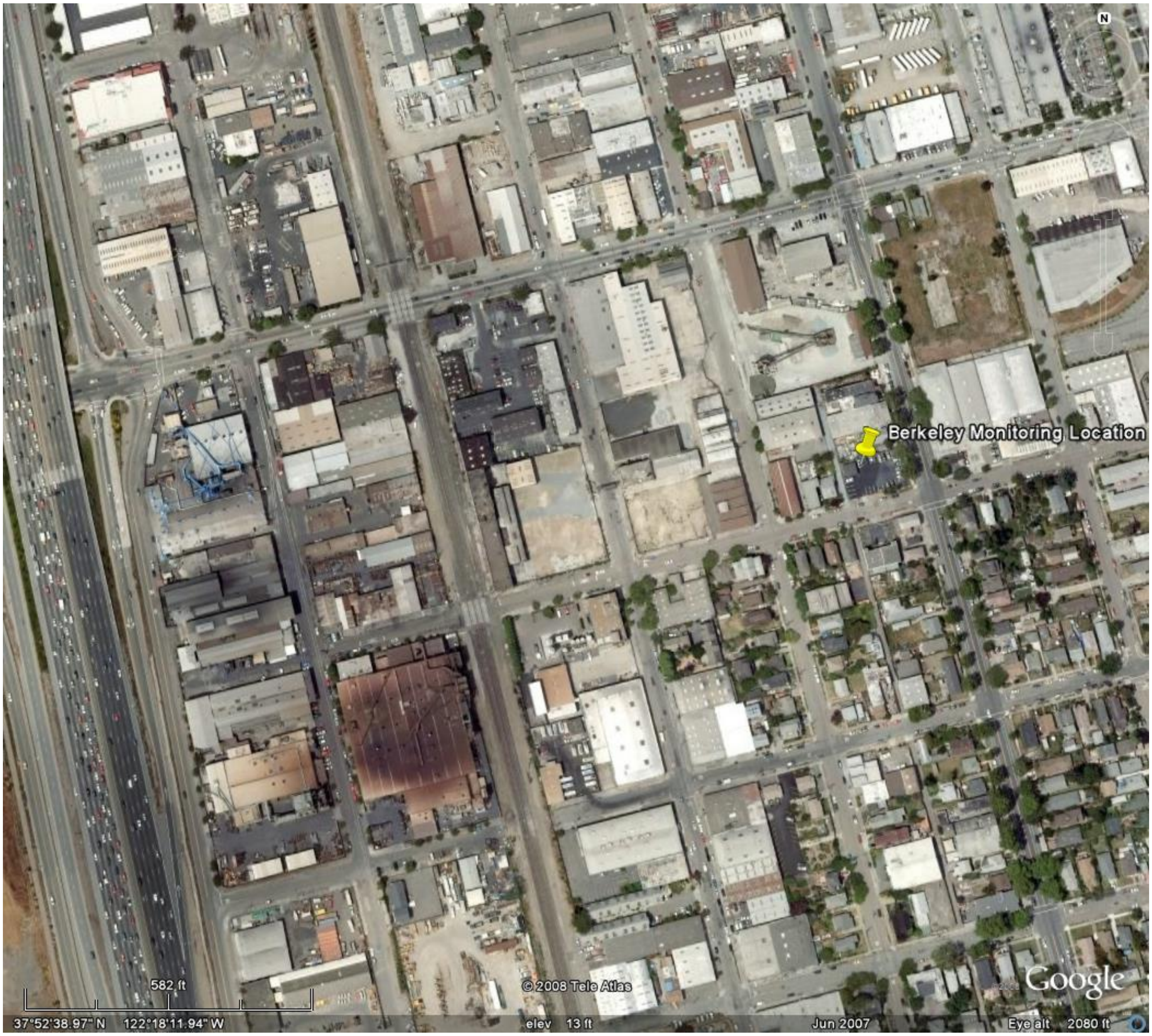

Figure 2. Cancer Risk Based on 2008 Ambient Air Monitoring Data

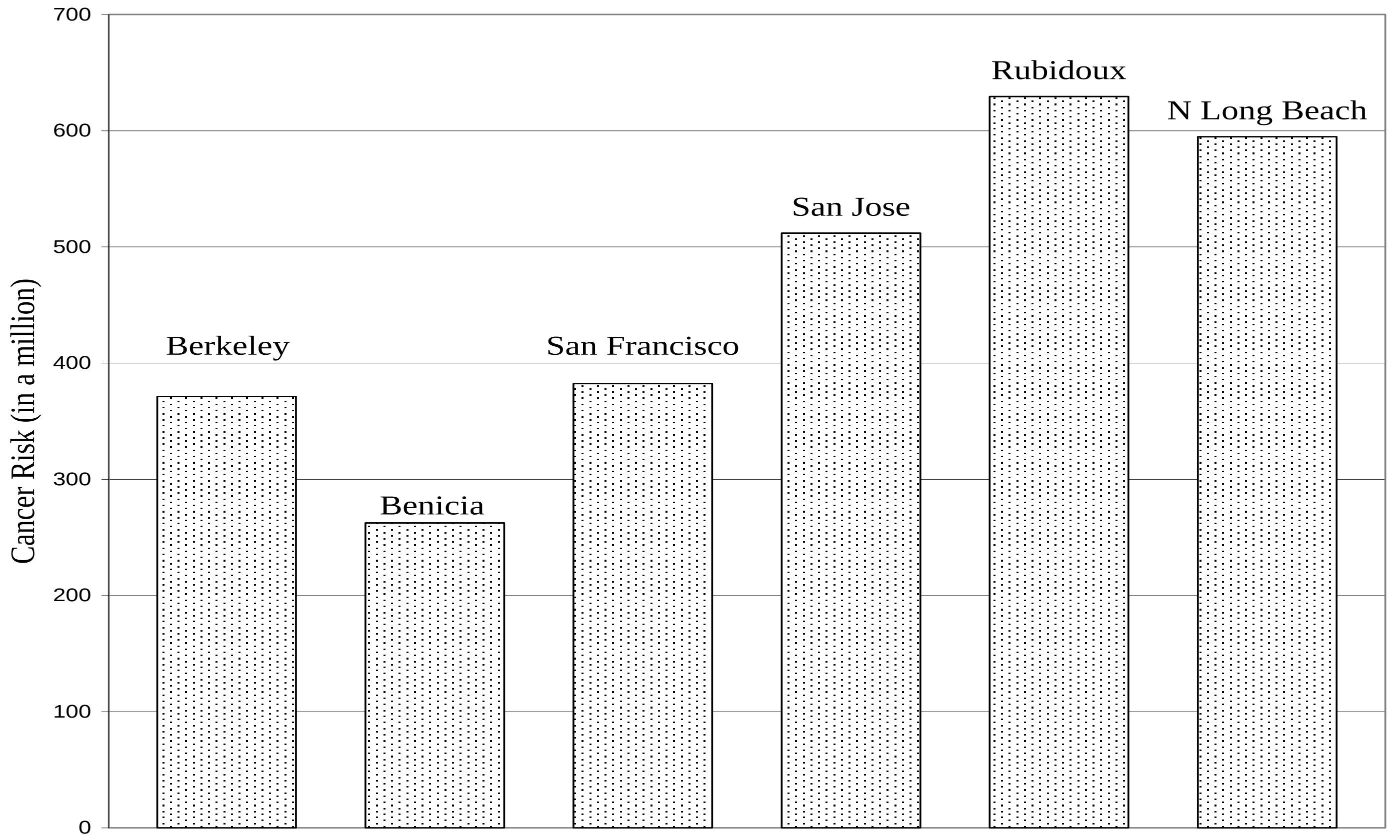

Figure 3. Chronic Noncancer Risk Based on 2008 Ambient Air Monitoring Data

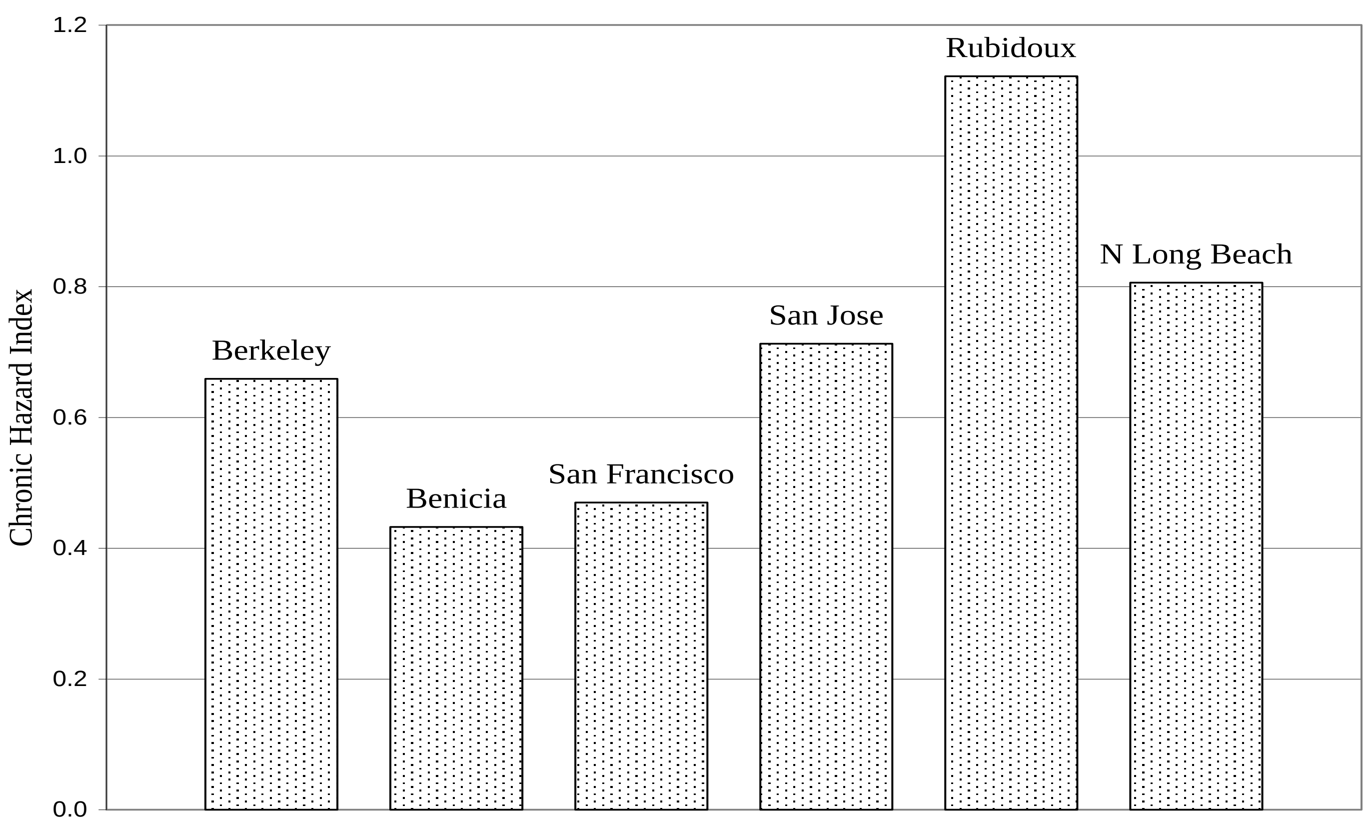

Figure 4. 8-Hour Noncancer Risk Based on 2008 Ambient Air Monitoring Data

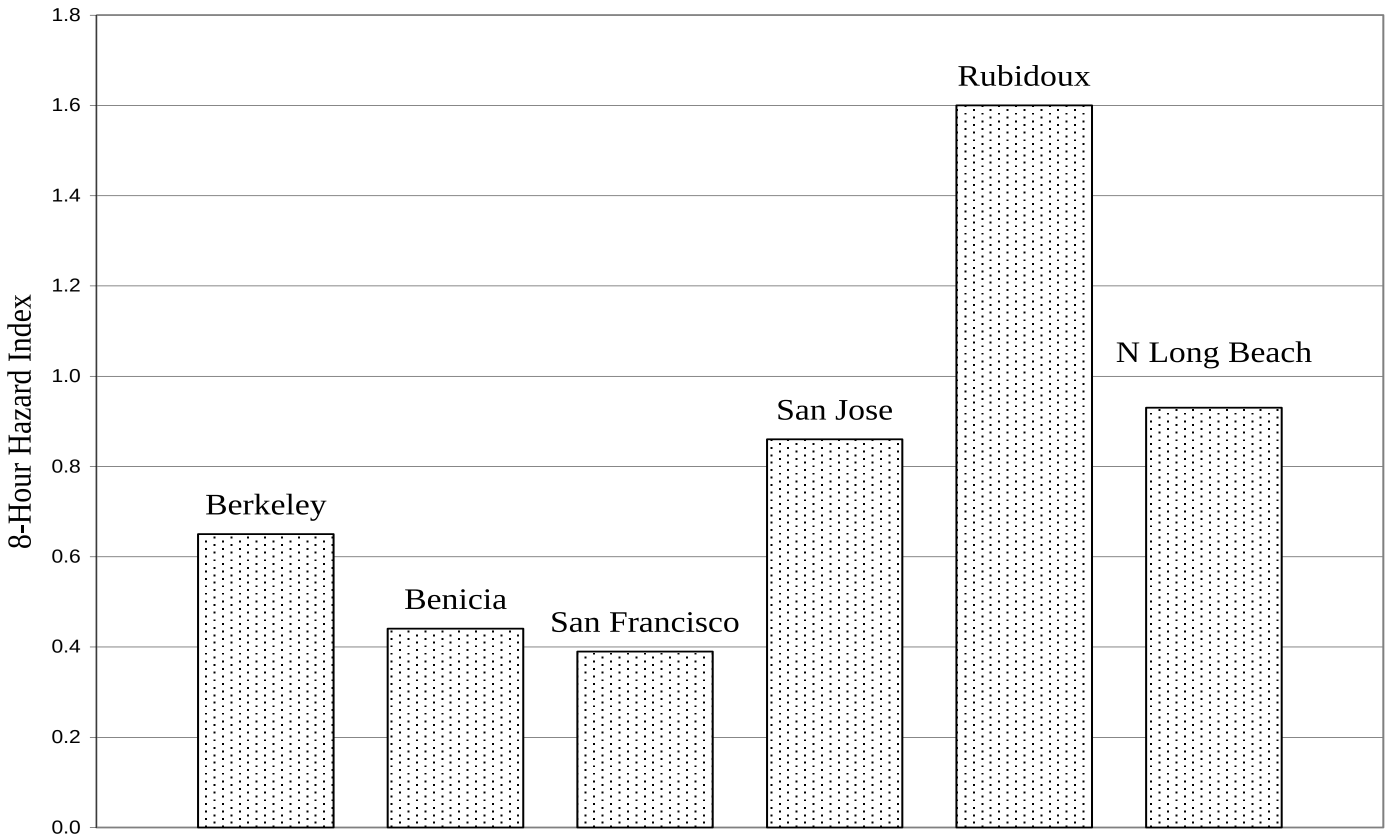

Figure 5. Acute Noncancer Risk Based on 2008 Ambient Air Monitoring Data