4.2 Metals

4.2.1 Method: The particulate metals (As, Be, Cd, Cr, Mn, Ni, Pb) were determined using high volume particulate samplers for TSP (total suspended particulate) for sample collection with subsequent sample digestion and analysis via atomic absorption (graphite furnace and flame detectors). The methodology employed for analysis is based on the EPA Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air, Method IO-3.2, "Determination of Metals in Ambient Particulate Matter Using Atomic Absorption (AA) Spectroscopy". [(11)]

4.2.2 Time Frame: The TSP samplers collected samples over a 24-hour period beginning at 01:00 hrs (EDT) on an every third day collection schedule. Samples were collected on the following days at each of the three sites: April 15, 18, 21, 24, 27, 30, May 3, 6, 9, 12, 15, 18, 21, 1999. No sample was collected at site MC1 on April 30, 1999 due to a power failure. Note: The NC DAQ's clocks were set to Eastern Daylight Savings Time (EDT) and the MCDEP's TSP samplers were set to Eastern Standard Time. Therefore the meteorological data sets were recalculated to obtain 24-hr averages that correlate to the same 24-hr sampling period as the TSP samplers.

4.2.3 Agency / Team Size: This team consisted of personnel from the MCDEP who were be responsible for initial set up, operation, sample collection, and analysis. NC DAQ personnel provided meteorological data.

4.2.4 Field Equipment / Supplies:

General Metal Works GMWL-2000 High Volume Air Sampling Systems
Whatman 8"x10" high Purity Quartz Microfiber filters
Calibration equipment and flow meter

4.2.5 Sampling Procedure:

The high volume TSP samplers were set up and operated as per EPA Compendium Method IO3.2.[(11)] Sampling apparatus were setup and retrieved by MCDEP personnel prior to and after each 24-hr sampling run. Samples were collected over a 24-hr period from 00:00 EST through 23:59 EST. The flowrate of the samplers was 1.1-1.7 m^3/minute (STP). Total air volume sampled ranged between 1700 m^3 - 2200 m^3 per sampling period. These volumes were recorded for each sample and used to calculate the ambient air concentration of the metals associated with the collected particulate samples.

4.2.6 Sample Analysis and Data Reduction:

Samples were retrieved as described above and returned to the MCDEP lab for sample preparation and analysis. Samples were prepared according to the procedures listed in Compendium Method IO-3.2 using an acid digestion extraction method. Sample extracts were then analyzed using a Perkin Elmer 5000 atomic absorption spectrometer for the seven metals of interest. Arsenic (As), beryllium (Be), cadmium (Cd), total chromium (Cr), nickel (Ni), and lead (Pb) were analyzed using the graphite furnace detector with a detection limit of 0.90 µg/filter. Manganese (Mn) was analyzed using the flame detector with a detection limit of 18 µg/filter. Filter blanks were analyzed for each metal using the respective detector. Arsenic, beryllium, cadmium filter blanks were below the minimum detection limit (0.90 µg/filter), as was the manganese filter blank (18 µg/filter). The filter blank results for chromium, nickel, and lead were 2.60, 2.77 and 1.48 µg/filter,

respectively. These values were subtracted from the values obtained for the samples as blank corrections. The minimum detectable limits (MDL) above can be used to calculate an approximate air concentration minimum detectable limit by dividing the "catch" weight (µg/filter) by the volume of air sampled. The calculated ambient air MDLs for As, Be, Cd, Cr, Ni, and Pb were 0.00045 $\mu g/m^3$ and for Mn was 0.0090 $\mu g/m^3$.

The values in Tables 4.2.1 through 4.2.7 are the values obtained from this calculation and represent the ambient air concentrations after correcting for the filter blanks in the cases of Cr, Ni, and Pb. The tables also include the 24-hr average wind direction and speed, the range of ambient air concentrations obtained from Reference 4 to which the sample concentrations are compared, and the MDL for the particular metal analysis.

Figures 4.2.1 through 4.2.7 depict the comparison between the ambient-concentration-range maximum value and the metal concentrations in the Tables. It is important to note that the concentrations obtained from these analyses have been directly compared to those in the reference from the ES&T journal article[(4)] because the values in this reference were obtained from studies that used the same or similar means of sampling and analysis as was used in this survey, i.e. particulate sampling and an atomic spectroscopic analysis techniques.[(5)]

Figures 4.2.8 through 4.2.10 show the average wind data for each site for each sampling day. At site MC1 the average wind direction was primarily from the southeast quadrant for eight of the thirteen sampling days, from the southwest quadrant for three days of sampling, one day from the west, and one day from the east-northeast. At site MC3, the average wind direction was primarily from the southeast, south, and southwest for eleven of the thirteen sampling days. At site MC2, data was incomplete or missing due to data logger malfunctions on 4/15, 5/9, and 5/12, for these days the meteorological data from site MC1 was plotted because of the two sites proximity. The average wind directions were out of the southeast quadrant for eight of thirteen sampling days, from the south one day, southwest quadrant for three days, and the northeast for one sampling day. As stated above, there was no readily discernable directional component to the sample metal concentrations (except as noted for cadmium) and no large excursions past the referenced values for any of the metals.

It can be seen from the Figures 4.2.1 through 4.2.7 that the metals concentrations in the collected air samples are lower than the ambient air concentration range maximums and is significantly lower for six of the seven metals. This means that the sample metals concentrations in the survey area were within the referenced values for ambient air concentrations and that there were no unusual excursions from this range to indicate a problem.

The only "metal of interest" that did exhibit some variability around the referenced range maximum was manganese. The individual sample concentration values and their average (0.0190 $\mu g/m^3$, n=22, sample values <MDL not included in the average) were in good agreement with the referenced value of 0.020 $\mu g/m^3$ as an upper limit for manganese in ambient air. Additionally, comparison of the Matthews sample concentration values with those obtained at an urban site in downtown Charlotte as reported in EPA's Aerometric Information Retrieval System (AIRS)[15] for 1988 (most recent data) show similar

concentrations. The AIRS data show manganese concentrations for the samples collected in 1988 to have an average concentration of 0.0230 $\mu g/m^3$, n=13 with a range of 0.0096-0.0385 $\mu g/m^3$.

The Matthews sample concentration values were observed from a variety of wind directions, which indicates that there is not a localized source. One possible ubiquitous source is from motor vehicles. This *may* be a source based on the use of manganese cyclopentyldienyl tricarbonyl (CAS# 12079-65-1) as a gasoline anti-knocking additive [12] although other sources can not be ruled out.

An additional note, there was one TSP sample that had a higher concentration of cadmium than the other samples in the survey, although the concentration was significantly lower than the range maximum for the ambient air cadmium concentration. The sample was collected on 5/21/99 at site MC2. The average wind direction was from the east-southeast. A similar trend was not noted for the other metals of interest in the sample thus indicating that the source may have been a specific cadmium containing source. The average wind direction at MC1 was also from the southeast during the same sampling period and a possible slight increase over other cadmium sample concentration values may be inferred. This could indicate that the source was local rather than a regional effect because there was no increase at the MC3 site (average wind direction from the south). It should be noted that the excursion was transient since there were at least 5 other samples taken when the average wind direction was from the southeast direction at both sites and no increase was noted in those samples.

Table 4.2.1 Metals Analysis- Matthews Monitoring Survey				
Arsenic			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air $\mu g/m^3$**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.00200	5.5	160.1
	MC2	0.00178	5.5 (MC1)	160.1 (MC1)
	MC3	0.00052	3.7	176.4
04/18/1999	MC1	0.00074	4.6	211.3
	MC2	0.00096	3.1	224.3
	MC3	0.00093	2.8	237.4
04/21/1999	MC1	0.00106	4.9	111.1
	MC2	0.00101	4.3	131.5
	MC3	0.00105	3.3	143.3
04/24/1999	MC1	0.00101	4.7	102.2
	MC2	0.00120	5.0	101.3
	MC3	0.00082	3.1	110.8
04/27/1999	MC1	0.00143	4.1	141.9
	MC2	0.00140	3.6	148.2
	MC3	0.00102	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	<0.00045*	9.5	23.9
	MC3	<0.00045*	6.8	48.7
05/03/1999	MC1	0.00110	5.1	173.3
	MC2	0.00155	3.2	181.9
	MC3	0.00133	2.9	173.8
05/06/1999	MC1	0.00086	5.0	144.5
	MC2	0.00151	4.4	161.1
	MC3	<0.00045*	3.4	195.6
05/09/1999	MC1	0.00138	3.7	223.9
	MC2	0.00096	3.7 (MC1)	223.9 (MC1)
	MC3	0.00141	1.8	244.6
05/12/1999	MC1	0.00120	3.8	220.1
	MC2	0.00130	3.8 (MC1)	220.1 (MC1)
	MC3	0.00179	2.1	148.6
05/15/1999	MC1	0.00134	6.3	278.0
	MC2	0.00105	5.0	114.8
	MC3	0.00109	3.2	48.4
05/18/1999	MC1	0.00239	3.2	129.2
	MC2	0.00258	2.5	111.3
	MC3	0.00157	2.2	147.8
05/21/1999	MC1	0.00088	3.5	150.8
	MC2	0.00182	2.6	165.1
	MC3	0.00142	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.012**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

Table 4.2.2 Metals Analysis- Matthews Monitoring Survey				
Beryllium			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air mg/m^3**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	<0.00045*	5.5	160.1
	MC2	<0.00045*	5.5 (MC1)	160.1 (MC1)
	MC3	<0.00045*	3.7	176.4
04/18/1999	MC1	<0.00045*	4.6	211.3
	MC2	<0.00045*	3.1	224.3
	MC3	<0.00045*	2.8	237.4
04/21/1999	MC1	<0.00045*	4.9	111.1
	MC2	<0.00045*	4.3	131.5
	MC3	<0.00045*	3.3	143.3
04/24/1999	MC1	<0.00045*	4.7	102.2
	MC2	<0.00045*	5.0	101.3
	MC3	<0.00045*	3.1	110.8
04/27/1999	MC1	<0.00045*	4.1	141.9
	MC2	<0.00045*	3.6	148.2
	MC3	<0.00045*	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	<0.00045*	9.5	23.9
	MC3	<0.00045*	6.8	48.7
05/03/1999	MC1	<0.00045*	5.1	173.3
	MC2	<0.00045*	3.2	181.9
	MC3	<0.00045*	2.9	173.8
05/06/1999	MC1	<0.00045*	5.0	144.5
	MC2	<0.00045*	4.4	161.1
	MC3	<0.00045*	3.4	195.6
05/09/1999	MC1	<0.00045*	3.7	223.9
	MC2	<0.00045*	3.7 (MC1)	223.9 (MC1)
	MC3	<0.00045*	1.8	244.6
05/12/1999	MC1	<0.00045*	3.8	220.1
	MC2	<0.00045*	3.8 (MC1)	220.1 (MC1)
	MC3	<0.00045*	2.1	148.6
05/15/1999	MC1	<0.00045*	6.3	278.0
	MC2	<0.00045*	5.0	114.8
	MC3	<0.00045*	3.2	48.4
05/18/1999	MC1	<0.00045*	3.2	129.2
	MC2	<0.00045*	2.5	111.3
	MC3	<0.00045*	2.2	147.8
05/21/1999	MC1	<0.00045*	3.5	150.8
	MC2	<0.00045*	2.6	165.1
	MC3	<0.00045*	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.0005**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

Table 4.2.3 Metals Analysis- Matthews Monitoring Survey				
Cadmium			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air $\mu g/m^3$**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.00079	5.5	160.1
	MC2	0.00095	5.5 (MC1)	160.1 (MC1)
	MC3	0.00147	3.7	176.4
04/18/1999	MC1	<0.00045*	4.6	211.3
	MC2	0.00046	3.1	224.3
	MC3	<0.00045*	2.8	237.4
04/21/1999	MC1	0.00101	4.9	111.1
	MC2	0.00067	4.3	131.5
	MC3	0.00121	3.3	143.3
04/24/1999	MC1	<0.00045*	4.7	102.2
	MC2	0.00090	5.0	101.3
	MC3	<0.00045*	3.1	110.8
04/27/1999	MC1	<0.00045*	4.1	141.9
	MC2	0.00099	3.6	148.2
	MC3	0.00083	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	0.00045	9.5	23.9
	MC3	<0.00045*	6.8	48.7
05/03/1999	MC1	0.00072	5.1	173.3
	MC2	0.00067	3.2	181.9
	MC3	0.00071	2.9	173.8
05/06/1999	MC1	0.00146	5.0	144.5
	MC2	0.00243	4.4	161.1
	MC3	<0.00045*	3.4	195.6
05/09/1999	MC1	0.00172	3.7	223.9
	MC2	0.00318	3.7 (MC1)	223.9 (MC1)
	MC3	0.00078	1.8	244.6
05/12/1999	MC1	0.00081	3.8	220.1
	MC2	0.00105	3.8 (MC1)	220.1 (MC1)
	MC3	0.00079	2.1	148.6
05/15/1999	MC1	0.00056	6.3	278.0
	MC2	0.00080	5.0	114.8
	MC3	0.00067	3.2	48.4
05/18/1999	MC1	0.00063	3.2	129.2
	MC2	0.00123	2.5	111.3
	MC3	0.00100	2.2	147.8
05/21/1999	MC1	0.00361	3.5	150.8
	MC2	0.03218	2.6	165.1
	MC3	0.00053	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.200**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

Table 4.2.4 Metals Analysis- Matthews Monitoring Survey				
Chromium			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air mg/m^3**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.00192	5.5	160.1
	MC2	0.00121	5.5 (MC1)	160.1 (MC1)
	MC3	0.00315	3.7	176.4
04/18/1999	MC1	0.00186	4.6	211.3
	MC2	0.00113	3.1	224.3
	MC3	0.00140	2.8	237.4
04/21/1999	MC1	0.00133	4.9	111.1
	MC2	0.00168	4.3	131.5
	MC3	0.00342	3.3	143.3
04/24/1999	MC1	0.00132	4.7	102.2
	MC2	0.00133	5.0	101.3
	MC3	0.00118	3.1	110.8
04/27/1999	MC1	0.00169	4.1	141.9
	MC2	0.00261	3.6	148.2
	MC3	0.00391	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	0.00107	9.5	23.9
	MC3	<0.00045*	6.8	48.7
05/03/1999	MC1	0.00212	5.1	173.3
	MC2	0.00176	3.2	181.9
	MC3	0.00103	2.9	173.8
05/06/1999	MC1	0.00065	5.0	144.5
	MC2	0.00181	4.4	161.1
	MC3	0.00068	3.4	195.6
05/09/1999	MC1	0.00056	3.7	223.9
	MC2	0.00047	3.7 (MC1)	223.9 (MC1)
	MC3	0.00262	1.8	244.6
05/12/1999	MC1	0.00112	3.8	220.1
	MC2	0.00089	3.8 (MC1)	220.1 (MC1)
	MC3	0.00090	2.1	148.6
05/15/1999	MC1	<0.00045*	6.3	278.0
	MC2	0.00105	5.0	114.8
	MC3	<0.00045*	3.2	48.4
05/18/1999	MC1	0.00063	3.2	129.2
	MC2	0.00081	2.5	111.3
	MC3	0.00100	2.2	147.8
05/21/1999	MC1	0.00479	3.5	150.8
	MC2	0.00140	2.6	165.1
	MC3	0.00100	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.120**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

Table 4.2.5 Metals Analysis- Matthews Monitoring Survey				
Manganese			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air mg/m^3**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.02500	5.5	160.1
	MC2	0.02075	5.5 (MC1)	160.1 (MC1)
	MC3	0.02624	3.7	176.4
04/18/1999	MC1	<0.00900*	4.6	211.3
	MC2	<0.00900*	3.1	224.3
	MC3	<0.00900*	2.8	237.4
04/21/1999	MC1	0.01762	4.9	111.1
	MC2	0.01679	4.3	131.5
	MC3	0.02628	3.3	143.3
04/24/1999	MC1	0.01752	4.7	102.2
	MC2	0.01713	5.0	101.3
	MC3	0.01531	3.1	110.8
04/27/1999	MC1	<0.00900*	4.1	141.9
	MC2	<0.00900*	3.6	148.2
	MC3	<0.00900*	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	0.01234	9.5	23.9
	MC3	<0.00900*	6.8	48.7
05/03/1999	MC1	0.01696	5.1	173.3
	MC2	<0.00900*	3.2	181.9
	MC3	0.02040	2.9	173.8
05/06/1999	MC1	<0.00900*	5.0	144.5
	MC2	<0.00900*	4.4	161.1
	MC3	<0.00900*	3.4	195.6
05/09/1999	MC1	<0.00900*	3.7	223.9
	MC2	<0.00900*	3.7 (MC1)	223.9 (MC1)
	MC3	<0.00900*	1.8	244.6
05/12/1999	MC1	0.01708	3.8	220.1
	MC2	0.01677	3.8 (MC1)	220.1 (MC1)
	MC3	0.03151	2.1	148.6
05/15/1999	MC1	<0.00900*	6.3	278.0
	MC2	0.01676	5.0	114.8
	MC3	0.01035	3.2	48.4
05/18/1999	MC1	0.01259	3.2	129.2
	MC2	0.02115	2.5	111.3
	MC3	0.02099	2.2	147.8
05/21/1999	MC1	<0.00900*	3.5	150.8
	MC2	0.02112	2.6	165.1
	MC3	0.02629	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.020**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00900		

Table 4.2.6 Metals Analysis- Matthews Monitoring Survey				
Nickel			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air mg/m^3**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.00255	5.5	160.1
	MC2	0.00096	5.5 (MC1)	160.1 (MC1)
	MC3	0.00132	3.7	176.4
04/18/1999	MC1	0.00113	4.6	211.3
	MC2	0.00051	3.1	224.3
	MC3	0.00352	2.8	237.4
04/21/1999	MC1	0.00230	4.9	111.1
	MC2	0.00085	4.3	131.5
	MC3	0.00443	3.3	143.3
04/24/1999	MC1	0.00084	4.7	102.2
	MC2	0.00177	5.0	101.3
	MC3	0.00103	3.1	110.8
04/27/1999	MC1	0.00066	4.1	141.9
	MC2	0.00059	3.6	148.2
	MC3	0.00108	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	0.00165	9.5	23.9
	MC3	0.00216	6.8	48.7
05/03/1999	MC1	0.00230	5.1	173.3
	MC2	<0.00045*	3.2	181.9
	MC3	0.00129	2.9	173.8
05/06/1999	MC1	0.00096	5.0	144.5
	MC2	0.00240	4.4	161.1
	MC3	<0.00045*	3.4	195.6
05/09/1999	MC1	0.00147	3.7	223.9
	MC2	<0.00045*	3.7 (MC1)	223.9 (MC1)
	MC3	0.00095	1.8	244.6
05/12/1999	MC1	0.00061	3.8	220.1
	MC2	0.00135	3.8 (MC1)	220.1 (MC1)
	MC3	0.00258	2.1	148.6
05/15/1999	MC1	0.00066	6.3	278.0
	MC2	0.00097	5.0	114.8
	MC3	0.00198	3.2	48.4
05/18/1999	MC1	0.00114	3.2	129.2
	MC2	0.00166	2.5	111.3
	MC3	0.00106	2.2	147.8
05/21/1999	MC1	0.00228	3.5	150.8
	MC2	0.00178	2.6	165.1
	MC3	0.00196	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.600**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

Table 4.2.7 Metals Analysis- Matthews Monitoring Survey				
Lead			**24hr avg. (01:00 to 01:00 EDT)**	
Sample Date	**Site**	**Ambient Air mg/m^3**	**WSP (mph)**	**WDR (°)**
04/15/1999	MC1	0.01156	5.5	160.1
	MC2	0.01144	5.5 (MC1)	160.1 (MC1)
	MC3	0.01000	3.7	176.4
04/18/1999	MC1	0.00327	4.6	211.3
	MC2	0.00360	3.1	224.3
	MC3	0.00359	2.8	237.4
04/21/1999	MC1	0.00417	4.9	111.1
	MC2	0.00472	4.3	131.5
	MC3	0.00518	3.3	143.3
04/24/1999	MC1	0.00493	4.7	102.2
	MC2	0.00418	5.0	101.3
	MC3	0.00437	3.1	110.8
04/27/1999	MC1	0.00378	4.1	141.9
	MC2	0.00638	3.6	148.2
	MC3	0.01086	2.8	170.0
04/30/1999	MC1	Power Failure*	9.2	65.1
	MC2	0.00302	9.5	23.9
	MC3	0.00353	6.8	48.7
05/03/1999	MC1	0.00469	5.1	173.3
	MC2	0.00450	3.2	181.9
	MC3	0.00691	2.9	173.8
05/06/1999	MC1	0.00970	5.0	144.5
	MC2	0.00773	4.4	161.1
	MC3	0.00267	3.4	195.6
05/09/1999	MC1	0.00454	3.7	223.9
	MC2	0.00631	3.7 (MC1)	223.9 (MC1)
	MC3	0.01190	1.8	244.6
05/12/1999	MC1	0.00613	3.8	220.1
	MC2	0.00505	3.8 (MC1)	220.1 (MC1)
	MC3	0.00848	2.1	148.6
05/15/1999	MC1	0.00441	6.3	278.0
	MC2	0.00463	5.0	114.8
	MC3	0.00443	3.2	48.4
05/18/1999	MC1	0.00397	3.2	129.2
	MC2	0.00417	2.5	111.3
	MC3	0.00449	2.2	147.8
05/21/1999	MC1	0.00716	3.5	150.8
	MC2	0.00771	2.6	165.1
	MC3	0.00439	2.2	189.2
Range of Ambient Air Concentration[4]		**ND – 0.300**	* No sample or concentration below MDL	
Minimum Detection Limit		0.00045		

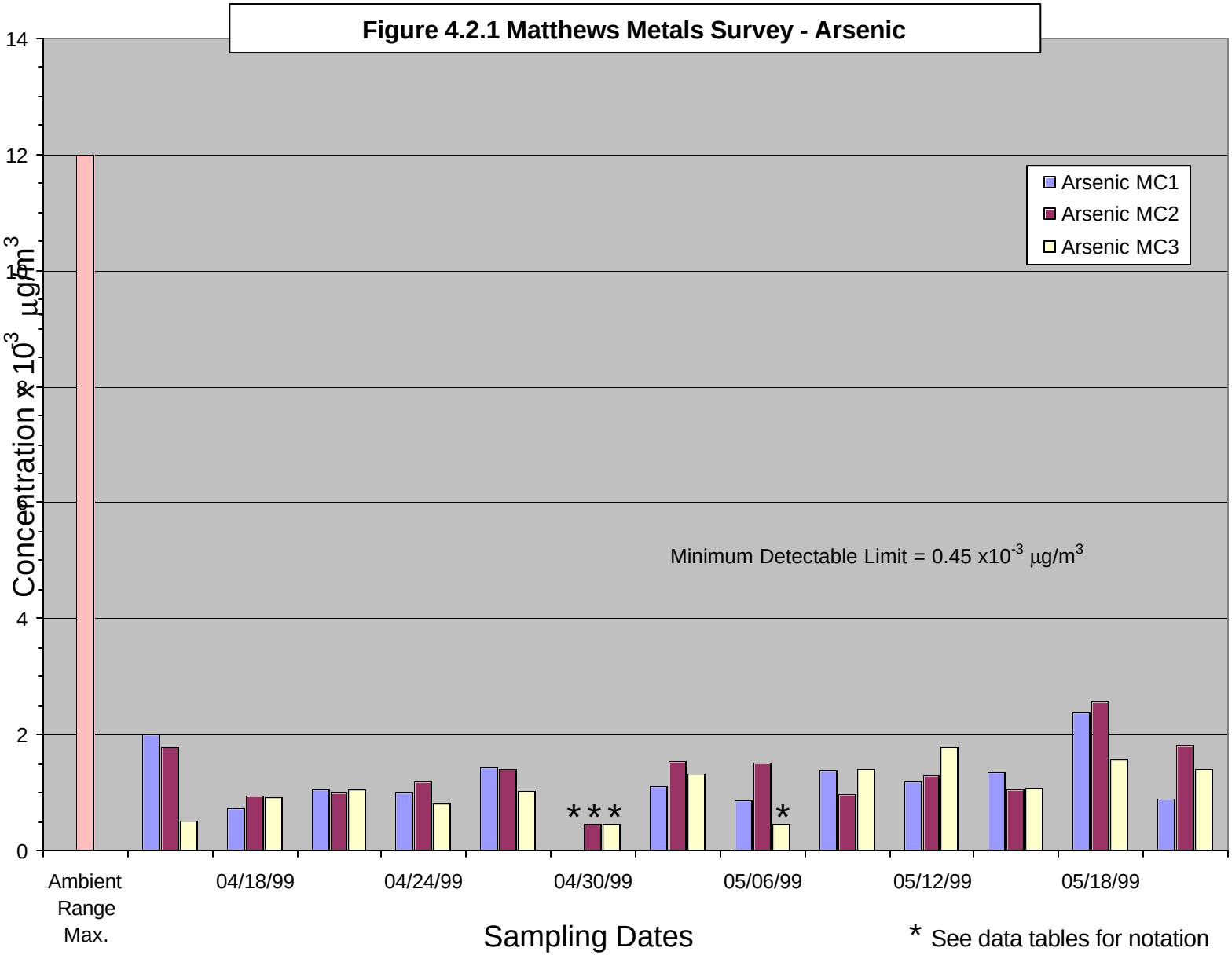


Figure 4.2.1 Matthews Metals Survey - Arsenic
Concentration x 10-3 µg/m3
14
12
10
8
6
4
2
0
Arsenic MC1
Arsenic MC2
Arsenic MC3
Minimum Detectable Limit = 0.45 x10-3 µg/m3
* * *
*
Ambient Range Max.
04/18/99
04/24/99
04/30/99
05/06/99
05/12/99
05/18/99
Sampling Dates
* See data tables for notation

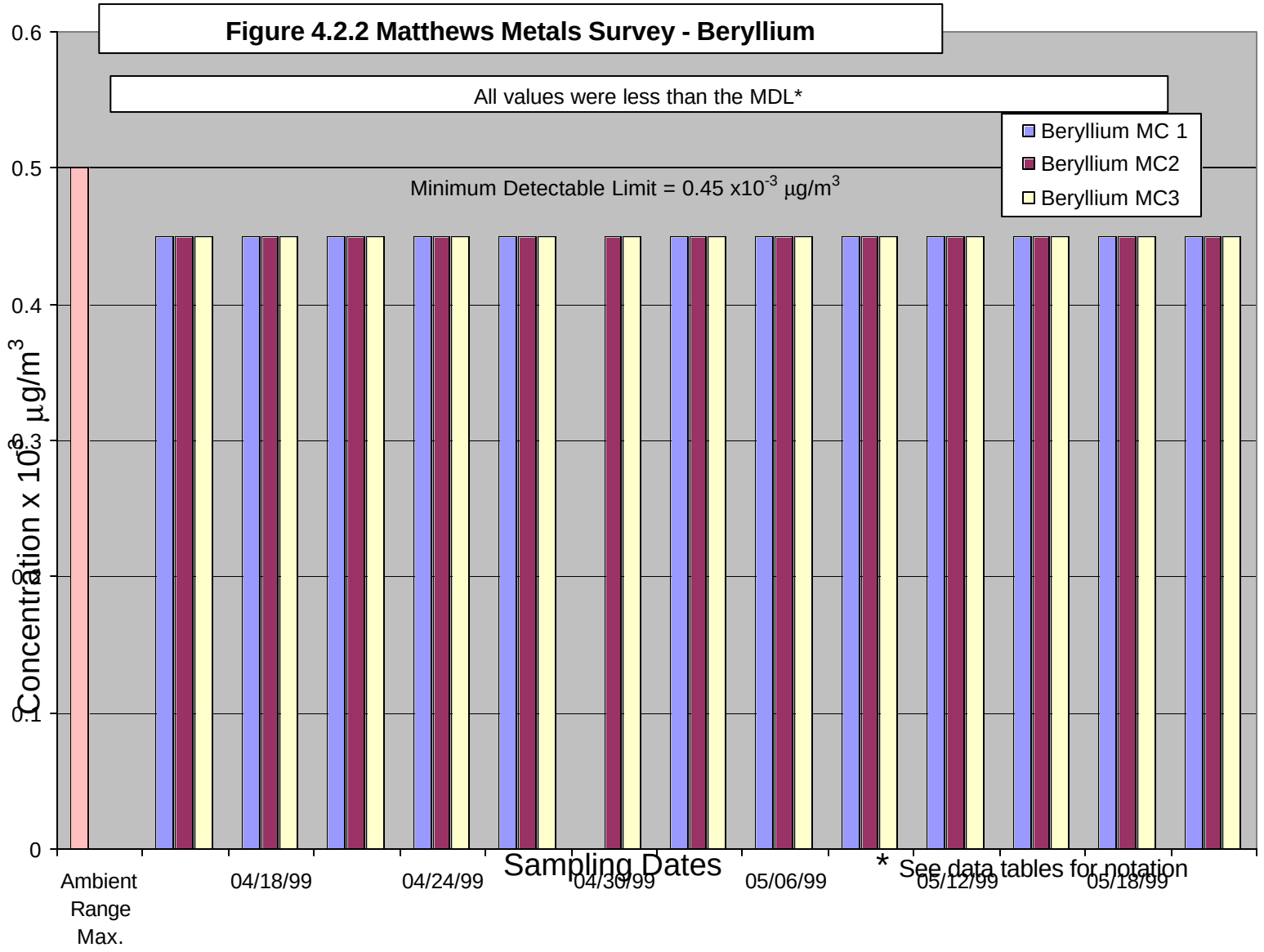


Figure 4.2.2 Matthews Metals Survey - Beryllium
All values were less than the MDL*
Minimum Detectable Limit = 0.45 x10-3 µg/m3
Beryllium MC 1
Beryllium MC2
Beryllium MC3
Concentration x 10-3 µg/m3
0.6
0.5
0.4
0.3
0.2
0.1
0
Ambient Range Max.
04/18/99
04/24/99
04/30/99
05/06/99
05/12/99
05/18/99
Sampling Dates
* See data tables for notation

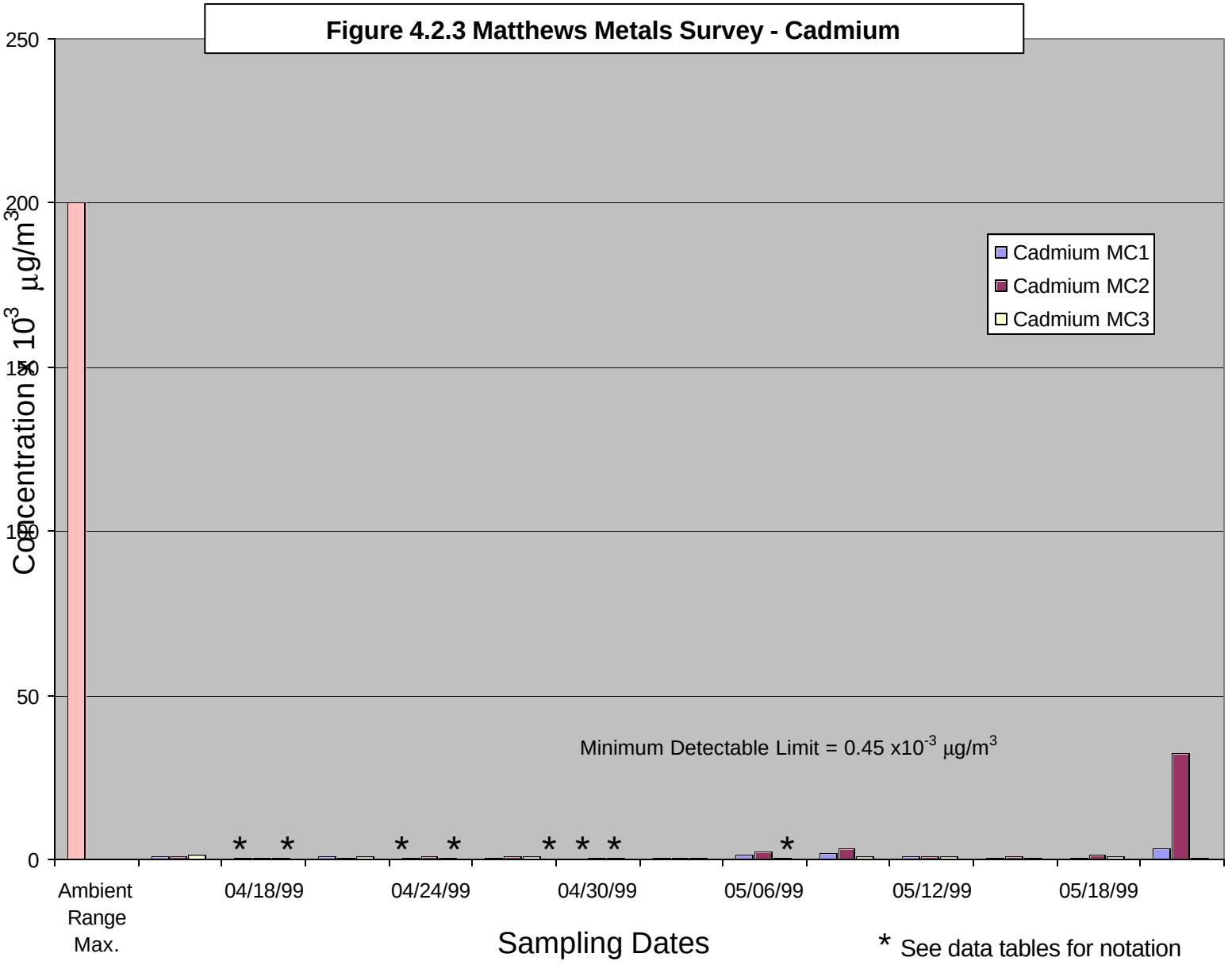
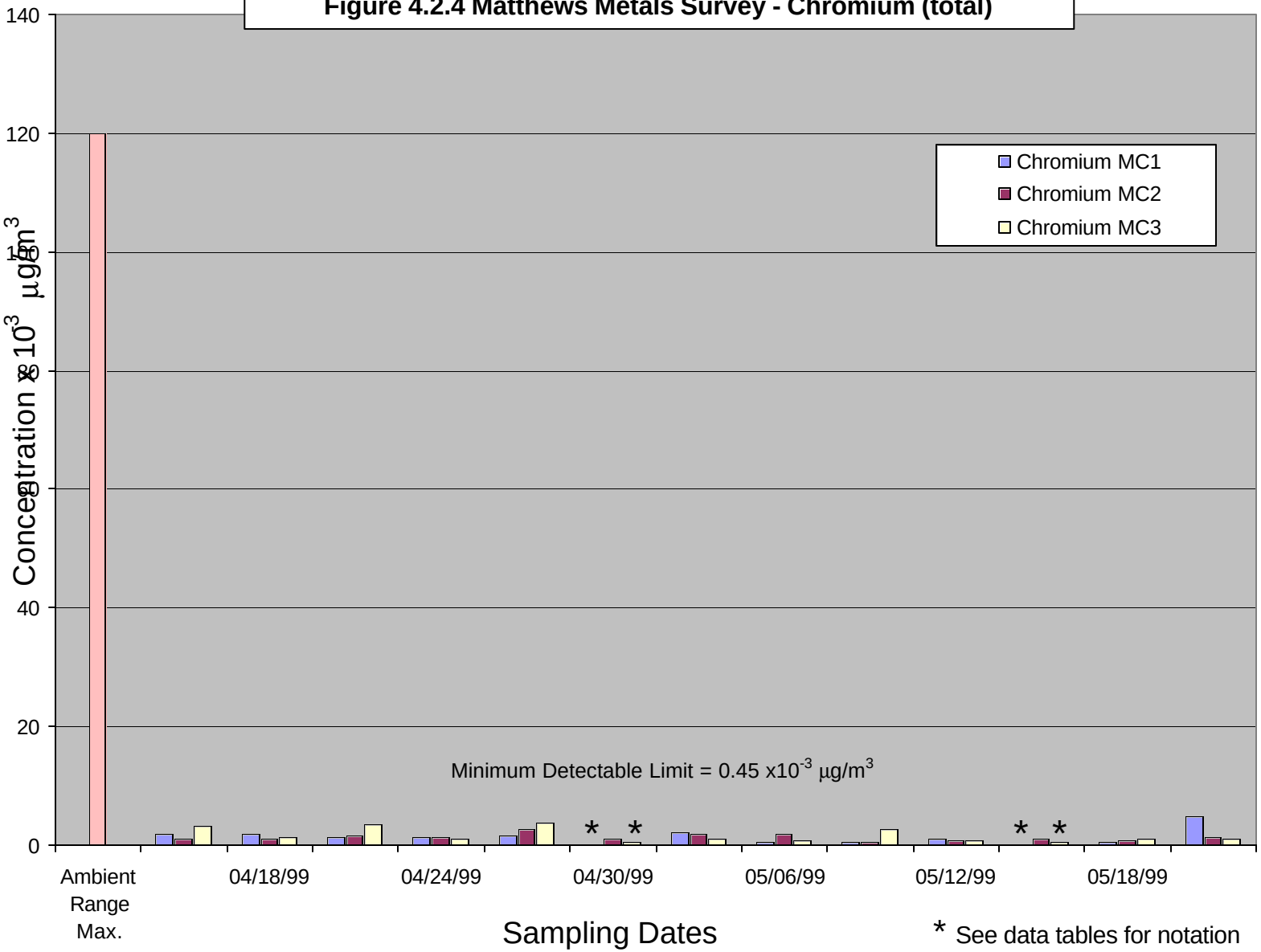


Figure 4.2.3 Matthews Metals Survey - Cadmium
250
200
150
100
50
0
Concentration x 10-3 µg/m3
Cadmium MC1
Cadmium MC2
Cadmium MC3
Minimum Detectable Limit = 0.45 x10-3 µg/m3
Ambient Range Max.
04/18/99
04/24/99
04/30/99
05/06/99
05/12/99
05/18/99
Sampling Dates
* See data tables for notation

Figure 4.2.4 Matthews Metals Survey - Chromium (total)



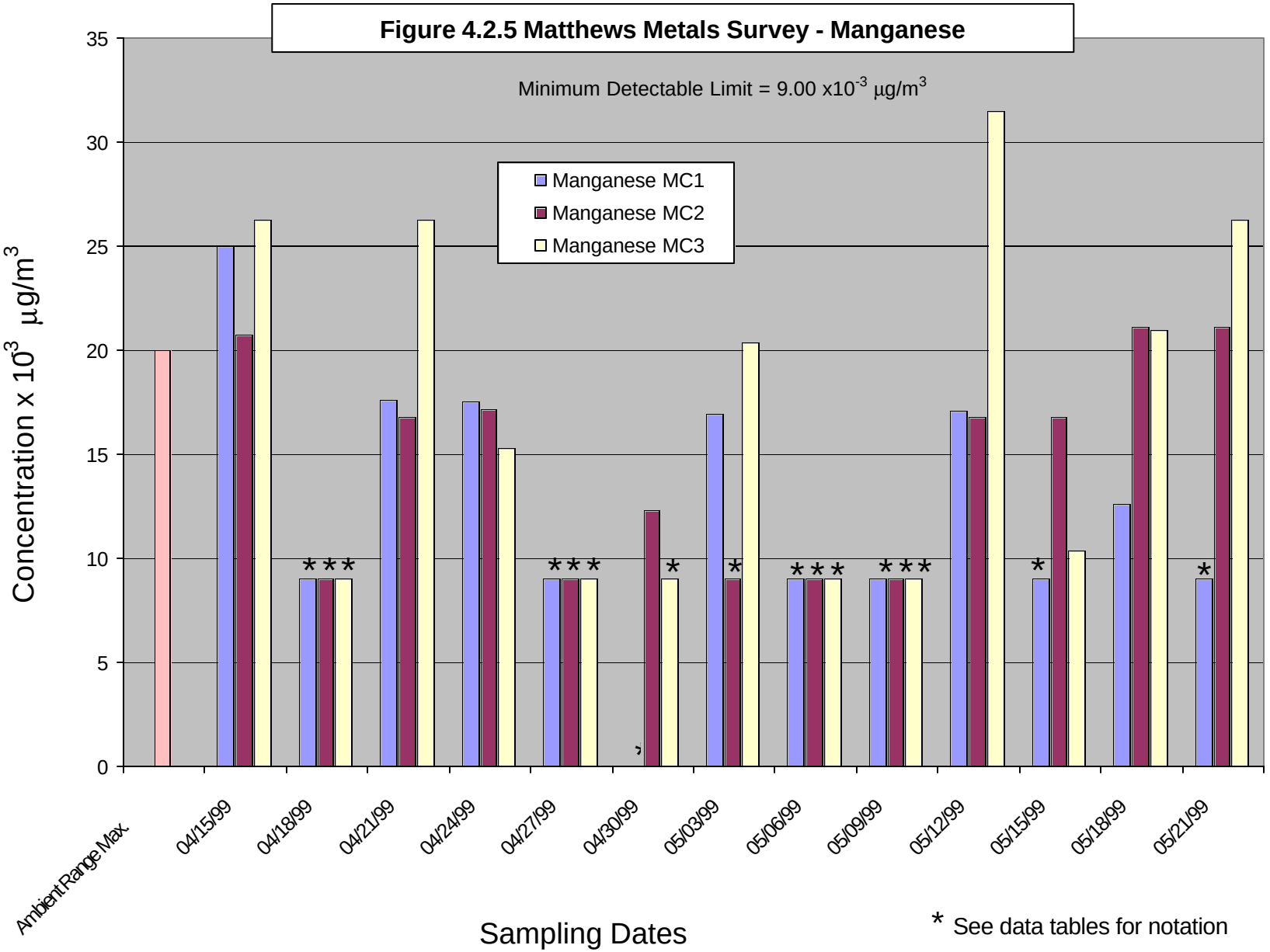


Figure 4.2.5 Matthews Metals Survey - Manganese
Minimum Detectable Limit = 9.00 x10-3 µg/m3
Manganese MC1
Manganese MC2
Manganese MC3
Concentration x 10-3 µg/m3
35
30
25
20
15
10
5
0
Ambient Range Max.
04/15/99
04/18/99
04/21/99
04/24/99
04/27/99
04/30/99
05/03/99
05/06/99
05/09/99
05/12/99
05/15/99
05/18/99
05/21/99
Sampling Dates
* See data tables for notation

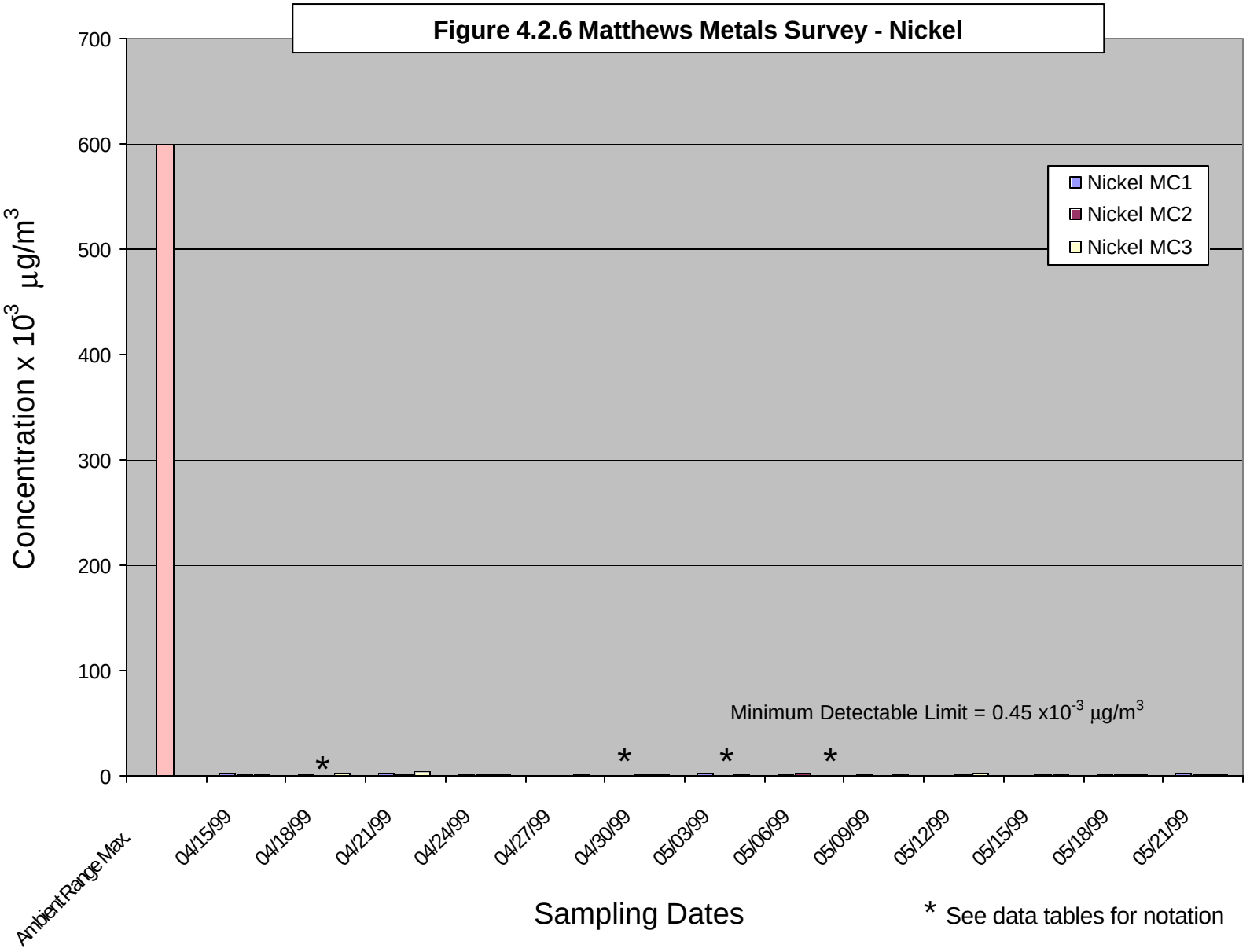
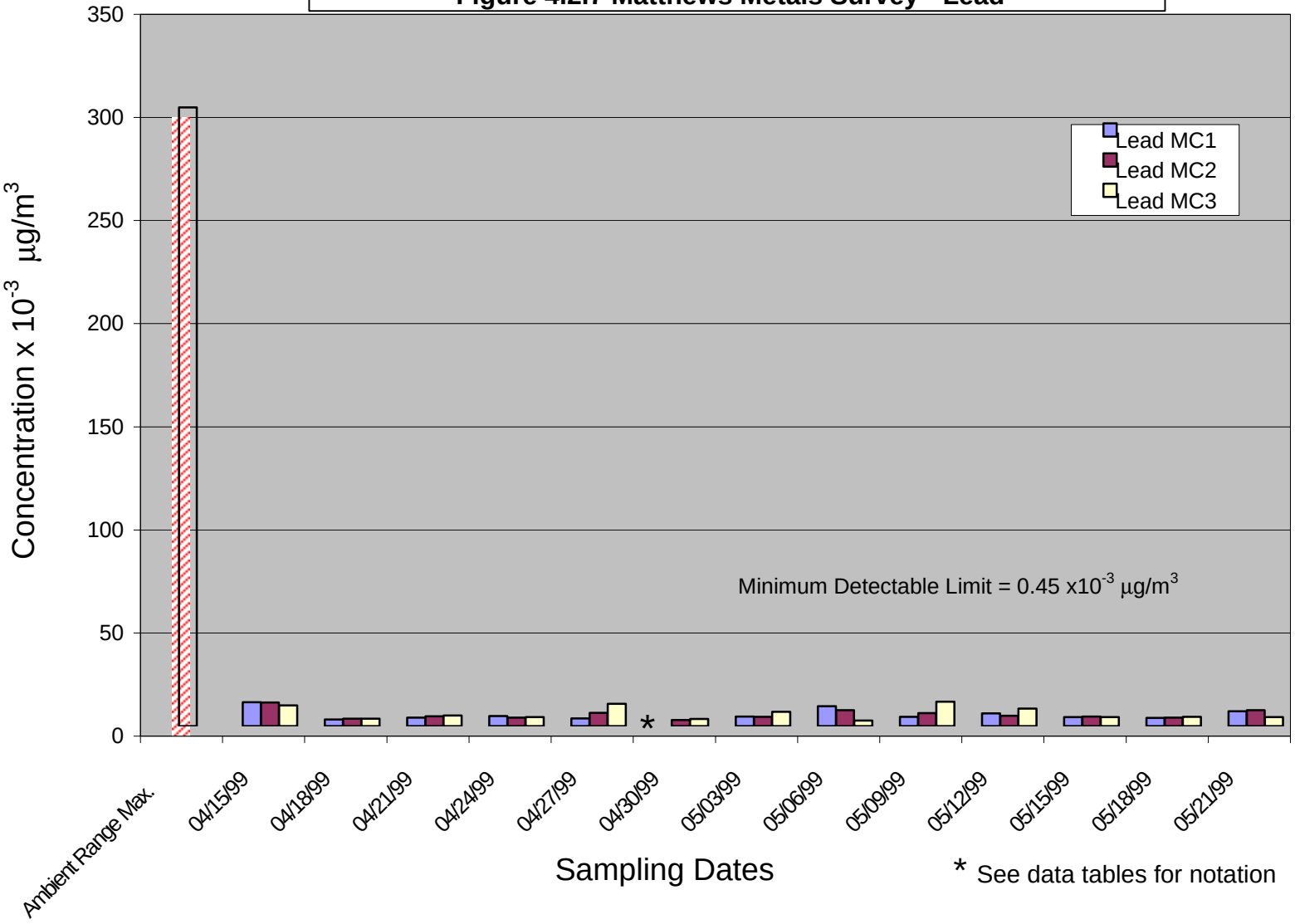
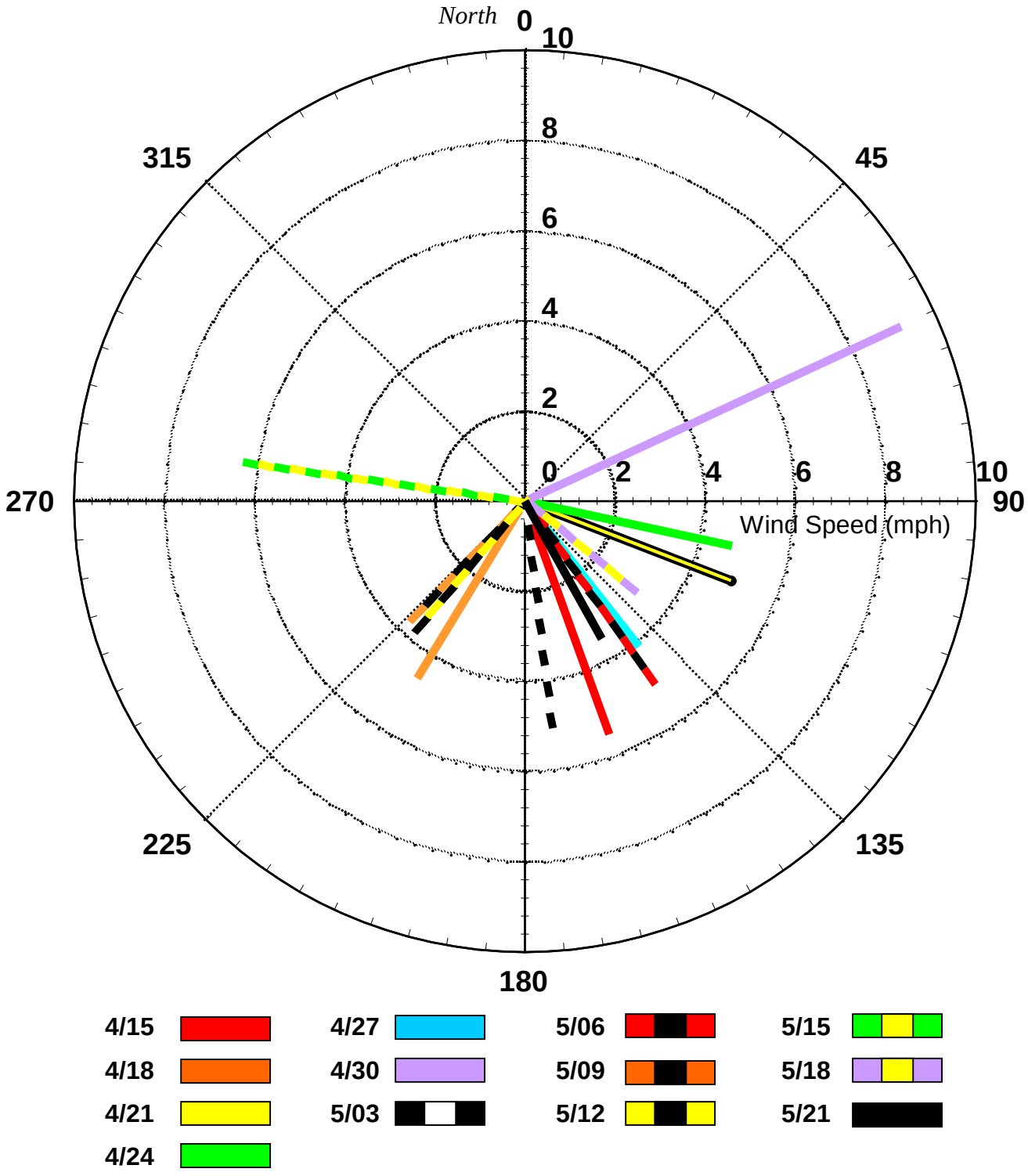


Figure 4.2.6 Matthews Metals Survey - Nickel
Concentration x 10^{3} µg/m^{3}
700
600
500
400
300
200
100
0
Nickel MC1
Nickel MC2
Nickel MC3
Minimum Detectable Limit = 0.45 x10^{-3} µg/m^{3}
*
*
*
*
Ambient Range Max.
04/15/99
04/18/99
04/21/99
04/24/99
04/27/99
04/30/99
05/03/99
05/06/99
05/09/99
05/12/99
05/15/99
05/18/99
05/21/99
Sampling Dates
* See data tables for notation

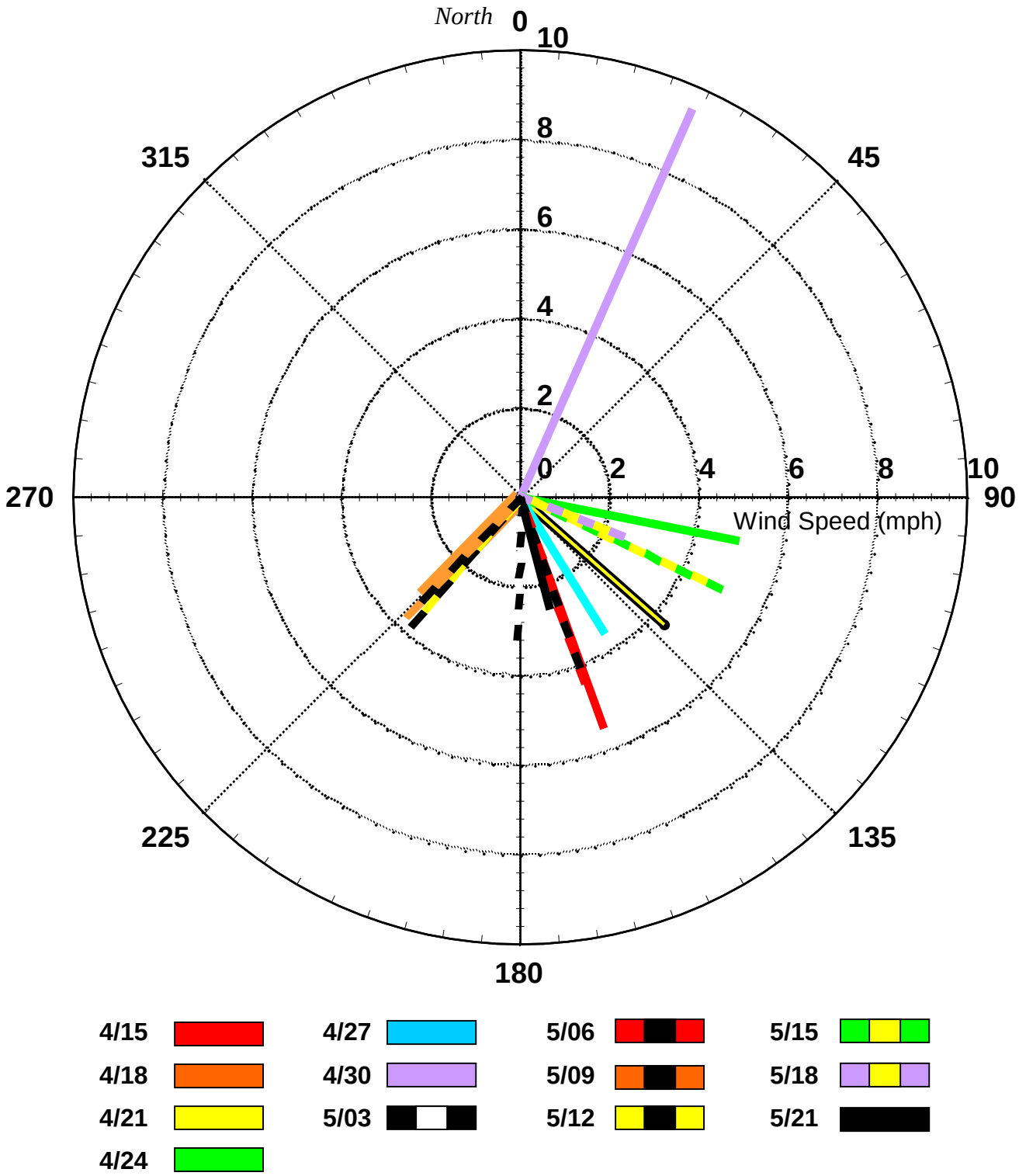
Figure 4.2.7 Matthews Metals Survey - Lead



Matthews Survey
Wind Direction vs Speed
Figure 4.2.8 - Site MC 1



Matthews Survey
Wind Direction vs Speed
Figure 4.2.9 - Site MC 2



Matthews Survey
Wind Direction vs Speed
Figure 4.2.10 - Site MC 3