Air Quality Monitoring
at
Denali National Park & Preserve, Alaska
2000 - 2003

March 8, 2012

Air Quality Division

Air Monitoring
&
Quality Assurance
Program

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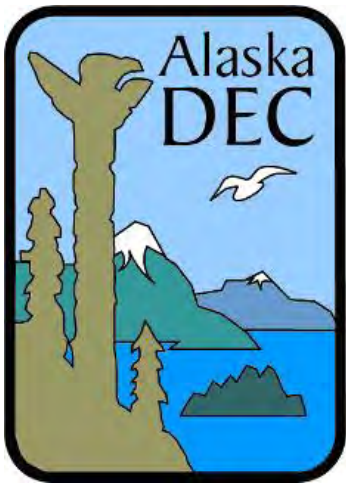

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Acknowledgements

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Introduction

In 1997 EPA required that all states establish $PM_{2.5}$ monitoring networks. The Alaska Department of Environmental Conservation (ADEC) incorporated this requirement into its existing, statewide network of regulatory and special purpose monitoring sites. ADEC maintains regulatory $PM_{2.5}$ monitoring sites in Juneau, Anchorage, the Matanuska-Susitna Borough, and Fairbanks. ADEC set up special purpose monitoring sites at Big Lake and Denali National Park and Preserve (Denali NPP) to gather airborne particulate ($PM_{2.5}$) data that could be useful in tracking particulate transport from the Anchorage metropolitan area to Denali NPP. Denali NPP is a Class I[1] area and is managed by the National Park Service (NPS) (Figure 1). ADEC established a $PM_{2.5}$ monitoring site at headquarters in the Denali NPP to measure background $PM_{2.5}$ levels in the State of Alaska. ADEC used a Federal Reference Method (FRM)[2] monitor for this project.

Figure 1. Map of national parks within the state of Alaska. Denali National Park and Preserve within dotted oval. (Map courtesy of NPS)

ADEC co-located its FRM monitors with Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors operated by the National Park Service. The IMPROVE

[1] Class I areas, as defined by the Clean Air Act, include national parks greater than 6,000 acres, wilderness areas, national memorial parks greater than 5,000 acres; and international parks that existed as of August 1977.

[2] A Federal Reference Method (FRM) is one that EPA has accepted for comparison to the National Ambient Air Quality Standards by meeting certain design, precision, and bias (performance) specifications (40 CFR Part 58).

monitors measure PM $_{2.5}$ and PM $_{10}$ in ambient air. Those data are used to assess the visibility impairment in Class I areas, such as Denali NPP, as well as to identify the sources of such impairment. The IMPROVE monitors capture particulates on four modules using a variety of filters. The PM $_{2.5}$ mass used by the IMPROVE method is speciated for a variety of other components.

ADEC compared the $PM_{2.5}$ FRM to the IMPROVE data and to the National Ambient Air Quality Standards (NAAQS) and used it to assess the air quality of Denali NPP as far as $PM_{2.5}$.

Methods

ADEC co-located its monitors with the NPS monitors near the water treatment plant and uphill from Denali NPP Headquarters (Figure 2). The monitoring shelter is at the end of a one-lane dirt road with average daily traffic estimated at less than 5 vehicles per day. The site is a considerable distance uphill from the main road into the park. That road is paved, but gets limited traffic in summer and virtually no traffic in winter. The road is not open beyond park headquarters in the winter.

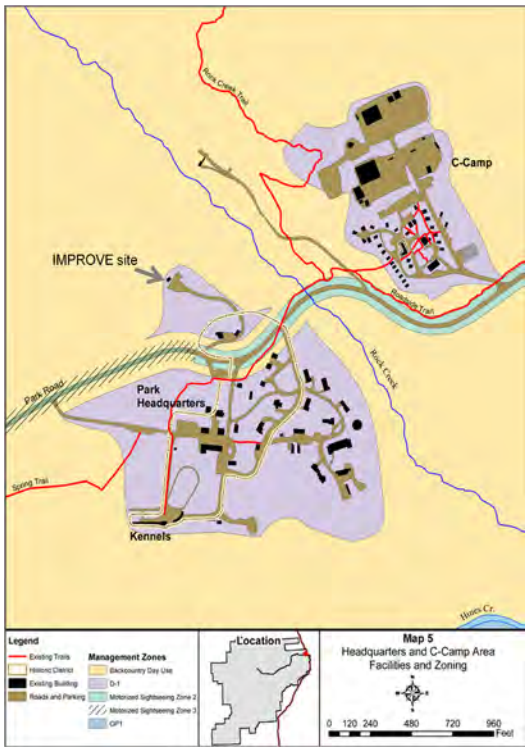

Figure 2. Map of Denali National Park and Preserve Headquarters area. Monitoring site located at arrow. (Map courtesy of NPS)

ADEC used Rupprecht &Patashnik (now Thermo Fisher Scientific) Partisol 2000 FRM $PM_{2.5}$ samplers configured with extended down-tubes (as approved by EPA for Alaska) at Denali NPP. The extended down-tubes put the sampler inlets at approximately the same height as the IMPROVE sampler inlets and allowed the inlets to clear the top of the shelter roof. This prevented airflow interference from the shelter itself and improved access to the monitors which were mounted on the side of the sampling shelter (Figure 3, Appendix A).

ADEC trained NPS staff in sampler operation, filter handling, and record keeping following EPA's protocols. The samplers used EPA Teflon filters which were pre-weighed and post-weighed in the ADEC Laboratory in Juneau. ADEC staff selected the monitoring site, conducted primary flow calibrations, and performed all monthly maintenance and quality control checks.

Figure 3. Partisol samplers installed at IMPROVE monitoring site at Denali NPP. IMPROVE inlets are visible on the far side of the shelter.

The ADEC FRM monitors initially sampled on a modified 1-in-3[3] schedule that matched the IMPROVE sampling schedule. The IMPROVE schedule was changed to match the EPA national 1-in-3 schedule on October 1, 2000. The Denali FRM $PM_{2.5}$ site operated from April 2000 through June 2003. ADEC decommissioned the site in June 2003 because the three consecutive years of $PM_{2.5}$ data capture mandated by EPA had been completed.

Results

Air Quality

Appendix B contains the sample data collected by the ADEC monitoring equipment and stored in EPA's Air Quality System (AQS) database.[4] The three highest 24-hour $PM_{2.5}$ values recorded were 33.7 µg/m^3 on July 8, 2000; 40.5 µg/m^3 on August 6, 2002; and 39.7 µg/m^3 on August 15, 2002 (Figure 4). ADEC believes these high values to have been caused by smoke from summer wild fires in the interior of the State. Wildfires frequently occur in interior Alaska in summer months and smoke can be transported many miles from its origin.

In general, $PM_{2.5}$values at the Denali NPP site were low – 97% of the sample values were 6 µg/m^3 or less (Figures 5, 6) and 75% of the samples were below the FRM minimum detection level (MDL) of 2 µg/m^3.[5] An area complied with the $PM_{2.5}$ 24-hour NAAQS in effect at the time of the study if the average of the 98th percentile values for three consecutive years was less than 65 µg/m^3 and with the annual NAAQS if the 3-year average of weighted annual means was less than 15 µg/m^3.[6] None of the 24-hour design values exceeded 65 µg/m^3, the NAAQS in effect at the time of the study, or 35 µg/m^3, the NAAQS in effect since 2006 (Table 1). None of the annual design values exceeded 15 µg/m^3. Tables 1 and 2 list the 24-hour and annual design values, the 1997 NAAQS that was in effect at the time of the study, and the current NAAQS in effect since 2006.

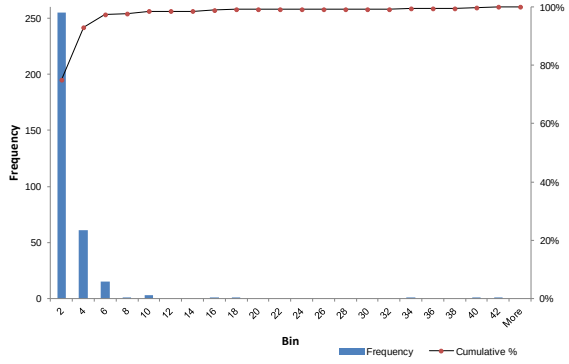

Figure 5. Frequency diagram showing distribution and cumulative frequencies of 24-hour average $PM_{2.5}$ data from ADEC FRM sampler.

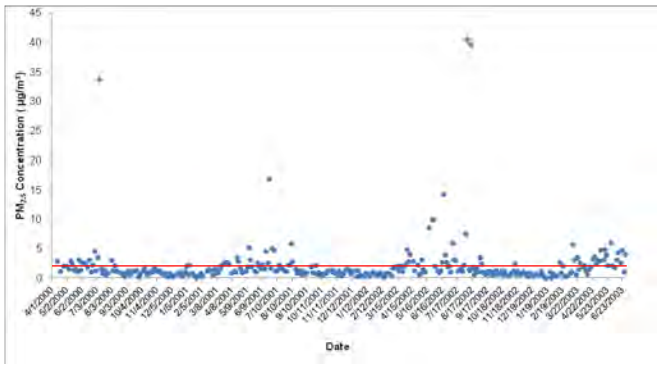

Figure 6. Scatter plot of 24-hour average $PM_{2.5}$ data from ADEC FRM sampler, orange line indicates minimum detection level of 2 µg/m^3.

[3] EPA specifies days throughout each year on which all federally referenced monitoring must take place. There are schedules that allow sampling once every three, six, or 12 days as well as daily.

[4] EPA restricts direct AQS access to those in federal, state, local, and tribal agencies who load data into the database or use data from the database for analysis. EPA provides public access to these data via its AirData web application. http://www.epa.gov/air/data/index.html

[5] EPA estimated the lower detection limit of the mass concentration range for $PM_{2.5}$ to be 2 µg/m^3 based on mass changes in field blanks (40CFR50 Appendix L). ADEC incorporated this value into its Quality Assurance Project Plan (QAPP) for $PM_{2.5}$.

[6] Refer to 40CFR Part 50 for detailed methodology.

Table 1. $PM_{2.5}$ 24-hour design values at Denali NPP, AK from 2000 through 2003. All concentrations are in µg/m³.

98th %	Year	2000	2001	2002	2003	NAAQS (1997)	NAAQS (2006)
4.5[1, 2]	2000	5				65	35
5.2	2001		5				
14.2	2002			8			
5.7[2]	2003				8		

[1] Number of years in the average < 3.

[2] Did not meet the minimum annual capture rate.

Table 2. $PM_{2.5}$ Annual design values at Denali NPP, AK from 2000 through 2003. All concentrations are in µg/m³.

Wtd. mean	Year	2000	2001	2002	2003	NAAQS (1997)	NAAQS (2006)
1.8[1, 2]	2000	1.8				15	15
1.6	2001		1.7				
2.5	2002			2.0			
2.0[2]	2003				2.0		

[1] Number of years in the average < 3.

[2] Did not meet the minimum annual capture rate.

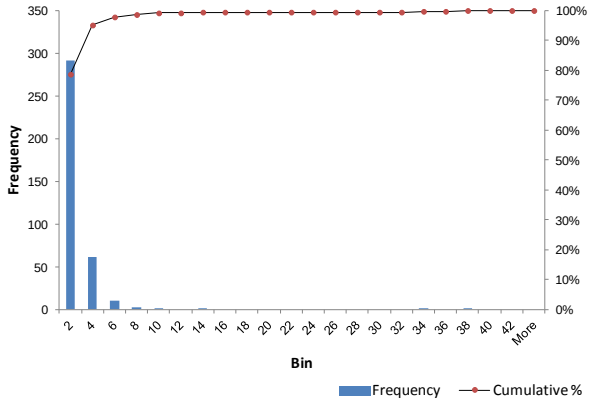

Figure 7. Frequency diagram showing distribution and cumulative frequencies of 24-hour average $PM_{2.5}$ data from IMPROVE sampler.

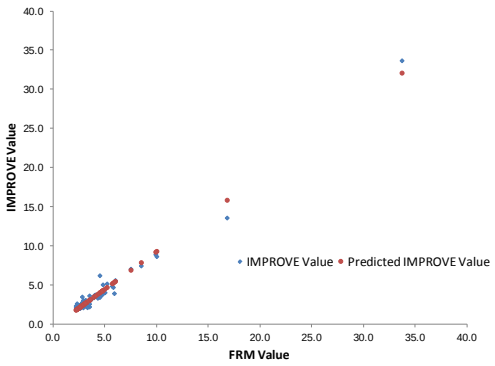

Figure 8. Linear regression of IMPROVE on FRM data; N = 68, r^2= 0.98, m = 0.96; b = -0.297.

Comparison to IMPROVE data

Appendix C contains the sample data collected by the IMPROVE monitoring equipment and stored in the NPS VIEWS integrated database.[7] As with the ADEC FRM data, the IMPROVE data showed that $PM_{2.5}$ values in Denali NPP were low – 98% of the sample values were 6 µg/m^3 or less and 79% were below 2 µg/m^3 (Figure 7). ADEC did a linear regression of FRM and IMPROVE data pairs (N=68) having values greater than or equal to the minimum detection limit of 2 µg/m^3 (Figure 8).[8] The regression coefficient (r^2) of 0.98 indicates that the linear regression line explains 98% of the variation between the two data sets.

Conclusions

$PM_{2.5}$ levels in Denali NPP, as measured at the IMPROVE site at park headquarters by both ADEC FRM and IMPROVE monitors, are very low. While IMPROVE data cannot be used to document compliance with the NAAQS, the Denali NPP IMPROVE data set demonstrated a very close correspondence with the FRM data set. Thus, the IMPROVE data from this site can be

[7] http://views.cira.colostate.edu/web/DataWizard/

[8] Data were paired by sample date; IMPROVE data rounded to one decimal point per AQS convention.

used to closely approximate FRM data. Unless there are major changes in $PM_{2.5}$ sources at Denali NPP, the State is unlikely to conduct $PM_{2.5}$ monitoring at this site again because of funding limits. However, since the IMPROVE monitoring is on-going, these data can be used to assess if and by how much $PM_{2.5}$ levels are changing at the Denali NPP site.

Appendix A
Site Photos and Specifications

The photos above show views from the samplers to all four cardinal directions.

Appendix B
$PM_{2.5}$ Data

DENALI NAT'L PARK - FRM DATA

Date	Date	Sample Value
20000412	4/12/2000	2.9
20000419	4/19/2000	1.1
20000426	4/26/2000	2
20000503	5/3/2000	2
20000506	5/6/2000	1.5
20000510	5/10/2000	2.9
20000513	5/13/2000	2.4
20000517	5/17/2000	1.4
20000520	5/20/2000	1.6
20000524	5/24/2000	1
20000527	5/27/2000	3.2
20000531	5/31/2000	1.4
20000603	6/3/2000	2.7
20000607	6/7/2000	2.6
20000610	6/10/2000	2.5
20000614	6/14/2000	1.8
20000617	6/17/2000	3.2
20000621	6/21/2000	1
20000624	6/24/2000	2.3
20000628	6/28/2000	4.5
20000701	7/1/2000	1.3
20000705	7/5/2000	3.5
20000708	7/8/2000	33.7
20000712	7/12/2000	1.6
20000715	7/15/2000	0.8
20000719	7/19/2000	1.5
20000722	7/22/2000	0.5
20000726	7/26/2000	0.8
20000802	8/2/2000	3
20000805	8/5/2000	1.3
20000809	8/9/2000	2.2
20000812	8/12/2000	1.3
20000816	8/16/2000	1
20000823	8/23/2000	0.8
20000826	8/26/2000	0.6
20000830	8/30/2000	0.3
20000902	9/2/2000	0.9
20000906	9/6/2000	1.1
20000909	9/9/2000	0.6
20000913	9/13/2000	1.2
20000916	9/16/2000	1
20000920	9/20/2000	1.3
20000923	9/23/2000	1.3
20000927	9/27/2000	0.1

20000930	9/30/2000	0.6
20001006	10/6/2000	1.2
20001009	10/9/2000	1.7
20001012	10/12/2000	1
20001015	10/15/2000	0.5
20001018	10/18/2000	0.8
20001021	10/21/2000	1
20001024	10/24/2000	1.2
20001027	10/27/2000	1
20001030	10/30/2000	1.7
20001102	11/2/2000	1.4
20001105	11/5/2000	1.2
20001108	11/8/2000	1.3
20001111	11/11/2000	1.1
20001114	11/14/2000	0.8
20001117	11/17/2000	0.6
20001120	11/20/2000	0.8
20001123	11/23/2000	0.3
20001126	11/26/2000	0.1
20001129	11/29/2000	0.7
20001202	12/2/2000	0.8
20001205	12/5/2000	0.1
20001208	12/8/2000	0.4
20001211	12/11/2000	0.5
20001214	12/14/2000	0.6
20001217	12/17/2000	0.6
20001220	12/20/2000	1
20001223	12/23/2000	0.9
20001226	12/26/2000	0.2
20001229	12/29/2000	0.8
20010101	1/1/2001	1.2
20010104	1/4/2001	2
20010107	1/7/2001	0.6
20010110	1/10/2001	2.3
20010113	1/13/2001	0.7
20010116	1/16/2001	0.8
20010119	1/19/2001	0.5
20010122	1/22/2001	0.2
20010125	1/25/2001	0
20010128	1/28/2001	0.2
20010131	1/31/2001	0.5
20010203	2/3/2001	0.8
20010206	2/6/2001	0.4
20010215	2/15/2001	1.1
20010218	2/18/2001	1.5
20010221	2/21/2001	1.3
20010224	2/24/2001	1.4

20010227	2/27/2001	0.5
20010302	3/2/2001	1.5
20010305	3/5/2001	1.6
20010308	3/8/2001	0.8
20010311	3/11/2001	0.9
20010314	3/14/2001	1.5
20010317	3/17/2001	2.2
20010323	3/23/2001	2.5
20010326	3/26/2001	2.7
20010329	3/29/2001	2.7
20010401	4/1/2001	2.4
20010407	4/7/2001	0.8
20010413	4/13/2001	1.1
20010416	4/16/2001	1
20010419	4/19/2001	3.5
20010422	4/22/2001	2.8
20010425	4/25/2001	1.7
20010428	4/28/2001	0.9
20010501	5/1/2001	1
20010507	5/7/2001	1.2
20010510	5/10/2001	1.9
20010513	5/13/2001	5.2
20010516	5/16/2001	3.2
20010519	5/19/2001	1.9
20010525	5/25/2001	1.1
20010528	5/28/2001	1
20010531	5/31/2001	2.6
20010603	6/3/2001	2
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20010609	6/9/2001	2.4
20010615	6/15/2001	1.6
20010618	6/18/2001	4.5
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20010627	6/27/2001	1.7
20010630	6/30/2001	5
20010703	7/3/2001	4.7
20010706	7/6/2001	1.2
20010709	7/9/2001	1.1
20010712	7/12/2001	1.4
20010715	7/15/2001	2.3
20010718	7/18/2001	1.7
20010721	7/21/2001	1.6
20010727	7/27/2001	1.2
20010730	7/30/2001	1.1
20010802	8/2/2001	2.3
20010805	8/5/2001	2.3

20010808	8/8/2001	5.8
20010811	8/11/2001	2.8
20010817	8/17/2001	1.6
20010820	8/20/2001	0.8
20010823	8/23/2001	1.3
20010826	8/26/2001	1.3
20010829	8/29/2001	0.6
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20010904	9/4/2001	0.6
20010907	9/7/2001	0.7
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20011206	12/6/2001	1.1
20011209	12/9/2001	0.7
20011212	12/12/2001	0.9
20011215	12/15/2001	1.3
20011221	12/21/2001	0.3
20011224	12/24/2001	1.3
20011227	12/27/2001	0.3
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20020117	1/17/2002	0.3
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20020126	1/26/2002	0.8
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20020204	2/4/2002	0.7
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20020213	2/13/2002	0.5
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20020219	2/19/2002	0.8
20020225	2/25/2002	0.8
20020228	2/28/2002	0.7
20020303	3/3/2002	0.4
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20020315	3/15/2002	2
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20020321	3/21/2002	2
20020324	3/24/2002	1.5
20020327	3/27/2002	1.2
20020330	3/30/2002	2.1
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20020701	7/1/2002	2

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20020815	8/15/2002	39.7
20020818	8/18/2002	1.8
20020821	8/21/2002	0.6
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20020827	8/27/2002	1.7
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20020902	9/2/2002	3.5
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20021011	10/11/2002	0.7
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20021023	10/23/2002	1.2
20021026	10/26/2002	0.6
20021029	10/29/2002	0.4
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20021104	11/4/2002	0.5
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20030103	1/3/2003	0.6
20030106	1/6/2003	1.1
20030109	1/9/2003	0.5
20030112	1/12/2003	0.4
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20030118	1/18/2003	0
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20030127	1/27/2003	0
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20030202	2/2/2003	0.7
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20030223	2/23/2003	0.4
20030226	2/26/2003	0.2
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20030403	4/3/2003	1.9
20030406	4/6/2003	2.2
20030409	4/9/2003	1.3
20030412	4/12/2003	0.6
20030415	4/15/2003	1.5
20030418	4/18/2003	1.9
20030424	4/24/2003	3.3
20030427	4/27/2003	3.6
20030430	4/30/2003	2.5
20030503	5/3/2003	3
20030506	5/6/2003	2.9
20030509	5/9/2003	4.7

20030515	5/15/2003	3.1
20030518	5/18/2003	4.8
20030521	5/21/2003	3.9
20030524	5/24/2003	2.1
20030530	5/30/2003	5.9
20030602	6/2/2003	2.1
20030605	6/5/2003	1.9
20030608	6/8/2003	1.8
20030611	6/11/2003	3.1
20030614	6/14/2003	4.3
20030620	6/20/2003	2.6
20030623	6/23/2003	4.7
20030626	6/26/2003	1
20030629	6/29/2003	4.1

DENALI NAT'L PARK - IMPROVE DATA

Date	Value	*-999 indicates no data
04/01/2000	2.0354	
04/05/2000	1.8103	
04/08/2000	1.4839	
04/12/2000	1.7883	
04/15/2000	2.193	
04/19/2000	0.4395	
04/22/2000	0.9239	
04/26/2000	0.7092	
04/29/2000	1.5662	
05/03/2000	1.2379	
05/06/2000	0.898	
05/10/2000	2.9131	
05/13/2000	2.2176	
05/17/2000	1.066	
05/20/2000	1.1075	
05/24/2000	0.8047	
05/27/2000	2.2651	
05/31/2000	1.5109	
06/03/2000	2.5819	
06/07/2000	2.4038	
06/10/2000	2.1961	
06/14/2000	1.8993	
06/17/2000	2.517	
06/21/2000	1.222	
06/24/2000	2.6228	
06/28/2000	6.2102	
07/01/2000	37.6933	
07/05/2000	2.2137	
07/08/2000	33.6905	
07/12/2000	2.2431	
07/15/2000	0.6453	
07/19/2000	1.1326	
07/22/2000	0.5365	
07/26/2000	0.586	
07/29/2000	3.2051	
08/02/2000	2.4952	
08/05/2000	0.298	
08/09/2000	2.335	
08/12/2000	0.7492	
08/16/2000	0.481	
08/19/2000	0.2104	
08/23/2000	0.3875	
08/26/2000	0.1203	
08/30/2000	0.591	

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09/06/2000	1.0568
09/09/2000	0.4529
09/13/2000	0.7278
09/16/2000	0.8497
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09/27/2000	-999
09/30/2000	-999
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10/12/2000	0.8911
10/15/2000	0.4067
10/18/2000	0.3142
10/21/2000	0.4439
10/24/2000	0.4589
10/27/2000	0.3321
10/30/2000	0.6659
11/02/2000	0.676
11/05/2000	0.5224
11/08/2000	0.3687
11/11/2000	0.731
11/14/2000	0.678
11/17/2000	0.2706
11/20/2000	0.2803
11/23/2000	0.3995
11/26/2000	0.219
11/29/2000	0.7008
12/02/2000	0.672
12/05/2000	0.2215
12/08/2000	0.3592
12/11/2000	0.2437
12/14/2000	0.403
12/17/2000	0.3805
12/20/2000	0.817
12/23/2000	0.341
12/26/2000	0.0313
12/29/2000	0.2114
01/01/2001	0.7407
01/04/2001	1.1931
01/07/2001	0.1286
01/10/2001	1.8854
01/13/2001	0.0646
01/16/2001	0.5109
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01/28/2001	0.222
01/31/2001	0.4522
02/03/2001	0.4012
02/06/2001	0.3071
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02/12/2001	0.8872
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03/08/2001	0.5531
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03/14/2001	1.4146
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03/20/2001	1.9015
03/23/2001	2.0743
03/26/2001	2.2197
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04/16/2001	0.6913
04/19/2001	3.6286
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04/28/2001	0.7785
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05/07/2001	0.9965
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05/16/2001	3.0093
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05/22/2001	0.4067
05/25/2001	0.6976
05/28/2001	0.8437
05/31/2001	1.6565
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06/09/2001	0.9654
06/12/2001	0.8099

06/15/2001	1.0707
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06/21/2001	2.0229
06/24/2001	13.584
06/27/2001	1.2237
06/30/2001	4.0332
07/03/2001	3.7395
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07/12/2001	1.0851
07/15/2001	1.5432
07/18/2001	1.9051
07/21/2001	1.2906
07/24/2001	1.014
07/27/2001	0.9833
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08/02/2001	2.2124
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08/08/2001	4.7013
08/11/2001	2.2531
08/14/2001	1.2871
08/17/2001	0.744
08/20/2001	0.775
08/23/2001	1.2711
08/26/2001	1.0095
08/29/2001	0.434
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09/04/2001	-999
09/07/2001	0.2949
09/10/2001	-999
09/13/2001	0.4122
09/16/2001	0.726
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09/22/2001	0.6976
09/25/2001	0.446
09/28/2001	2.0928
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10/04/2001	0.7407
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10/13/2001	0.5216
10/16/2001	0.4243
10/19/2001	0.5074
10/22/2001	0.8961
10/25/2001	0.7964
10/28/2001	0.8803
10/31/2001	0.4914

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11/06/2001	0.4279
11/09/2001	0.064
11/12/2001	0.0951
11/15/2001	0.6224
11/18/2001	0.2503
11/21/2001	0.5569
11/24/2001	0.3537
11/27/2001	0.4527
11/30/2001	1.6565
12/03/2001	1.2448
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12/18/2001	0.3079
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01/26/2002	0.6882
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02/13/2002	0.8477
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02/25/2002	1.0732
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04/02/2002	2.3891
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04/11/2002	3.7145
04/14/2002	2.8498
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04/20/2002	0.6481
04/23/2002	2.3579
04/26/2002	1.9255
04/29/2002	0.248
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05/08/2002	1.1098
05/11/2002	0.7964
05/14/2002	1.714
05/17/2002	4.7565
05/20/2002	7.4541
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05/26/2002	8.649
05/29/2002	8.8997
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10/29/2002	0.401
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11/13/2002	1.3194
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11/22/2002	0.3276
11/25/2002	0.2608
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01/12/2003	0.0329
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01/18/2003	0.0325
01/21/2003	1.0023
01/24/2003	0.7974
01/27/2003	0.2284
01/30/2003	0.1938
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02/08/2003	-0.031
02/11/2003	0.0326
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02/20/2003	1.3751
02/23/2003	0.1286
02/26/2003	0.0956
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03/07/2003	0.8601
03/10/2003	1.0831
03/13/2003	4.842
03/16/2003	2.644
03/19/2003	0.4382
03/22/2003	2.5784
03/25/2003	1.2595
03/28/2003	2.1181
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04/09/2003	1.1914
04/12/2003	0.601
04/15/2003	1.5844
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05/12/2003	1.8519
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05/21/2003	3.3711
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05/30/2003	3.9208
06/02/2003	1.3228
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06/08/2003	1.4858
06/11/2003	2.9565
06/14/2003	3.3269
06/17/2003	3.1965
06/20/2003	2.2721
06/23/2003	4.1344
06/26/2003	0.9455
06/29/2003	3.7574