



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**  
**Office of Air Quality Planning and Standards (OAQPS)**  
**Research Triangle Park, North Carolina 27711**

December 14, 2012

**MEMORANDUM**

---

**SUBJECT:** Evaluation of the Formula for Estimating the 98<sup>th</sup> Percentile Concentration for PM<sub>2.5</sub> Seasonal Sampling

**FROM:** Mark Schmidt, Air Quality Analysis Group, OAQPS/OAR /s/

**TO:** PM NAAQS Review Docket (EPA-HQ-OAR-2007-0492)

---

The EPA proposed to eliminate the special procedures used to estimate 98<sup>th</sup> percentile concentrations for comparison to the primary and secondary 24-hour PM<sub>2.5</sub> standards for monitoring sites with approved seasonal sampling schedules.(77 FR 39002, June 29, 2012).The proposal explained that with an approved seasonal sampling schedule, a site is typically required to sample during periods of the year when the highest concentrations are expected to occur, but less frequently during periods of the year when lower concentrations are expected to occur (77 FR 39002, June 29, 2012). This type of sampling schedule generally leads to an unbalanced data record; that is, a data record with proportionally more ambient measurements (with respect to the total number of days in the sampling period) in the “high” season and proportionally fewer ambient measurements in the “low” season.

In the last PM NAAQS review in 2006, the EPA revised section 4.5 of appendix N to include a special formula for computing annual 98<sup>th</sup> percentile values when a site operates on an approved seasonal sampling schedule. This special formula accounted for an unbalanced data record and was consistent with guidance documentation (US EPA, 1999), and, where

appropriate, with official OAQPS design value calculations (71 FR 61211, October 17, 2006). In cases where there is a balanced<sup>1</sup> (or near-balanced) data record, the special formula yields the same result as the regular procedure for calculating annual 98<sup>th</sup> percentile concentrations.

As EPA noted in the proposal, there are very few PM<sub>2.5</sub> FRM monitors that operated on an approved seasonal sampling schedule (only 15 sites out of approximately 1,000 total sites in 2010) and that for almost half of those sites, the required collocated continuous instrument was a PM<sub>2.5</sub> FEM (77 FR 39002, June 29, 2012). The proposal stated that for the 3-year period 2008 to 2010, the annual 98<sup>th</sup> percentile concentrations calculated with the special formula at those 15 sites were approximately five percent lower than if the regular procedure was used.

The purpose of this memorandum is to update the above results using 2009-2011 data and to present the trend in the computed difference between the two methods when used to estimate annual 98<sup>th</sup> percentiles and 24-hour design values. The results show a narrowing of the difference between the two methods for identifying annual 98<sup>th</sup> percentiles. Moreover, there are no instances in the 2009-2011 timeframe (i.e., 0 out of 12 monitoring sites) for which the seasonal-formula 24-hour design value meets the NAAQS but the corresponding regular-formula design value shows a violation. These findings can likely be attributed, at least in part, to the increasing network-wide deployment of Federal Equivalent Monitors (FEMs).

This evaluation of seasonal sampling looked at several issues: the extent of seasonal sampling recently and over time; the extent to which sites approved for seasonal sampling have had a collocated FEM; and the estimated difference between results from use of the special formula and those from the regular formula both for 98<sup>th</sup> percentiles and 24-hour design values. All data used in this evaluation were extracted from AQS on December 11, 2012.

---

<sup>1</sup> A balanced data record has the same proportion of ambient measurements (with respect to the total number of days in the sampling period) in the “high” season as in the “low” season.

Figure 1 shows the number of sites, by year, approved for seasonal sampling (as determined via AQS metadata) over the entire PM<sub>2.5</sub> regulatory timeframe (1999 through 2011). The number of sites approved for seasonal sampling ranged from around 18 to 20 for about the first ten years of the regulatory program, and then dropped dramatically during the most recent few years. In 2008, there were 20 sites (about two percent) with an approved seasonal sampling schedule. In 2011, there were only 12 sites with an approved seasonal sampling schedule (about 1.3 percent of the total). These data indicate a 40 percent reduction in the absolute number, and a 35 percent reduction in the annual proportion of total sites that have been approved for seasonal sampling over the most recent 4-year period.

**Figure 1. Number and percentage of sites with an approved seasonal sampling schedule, 1999-2011**

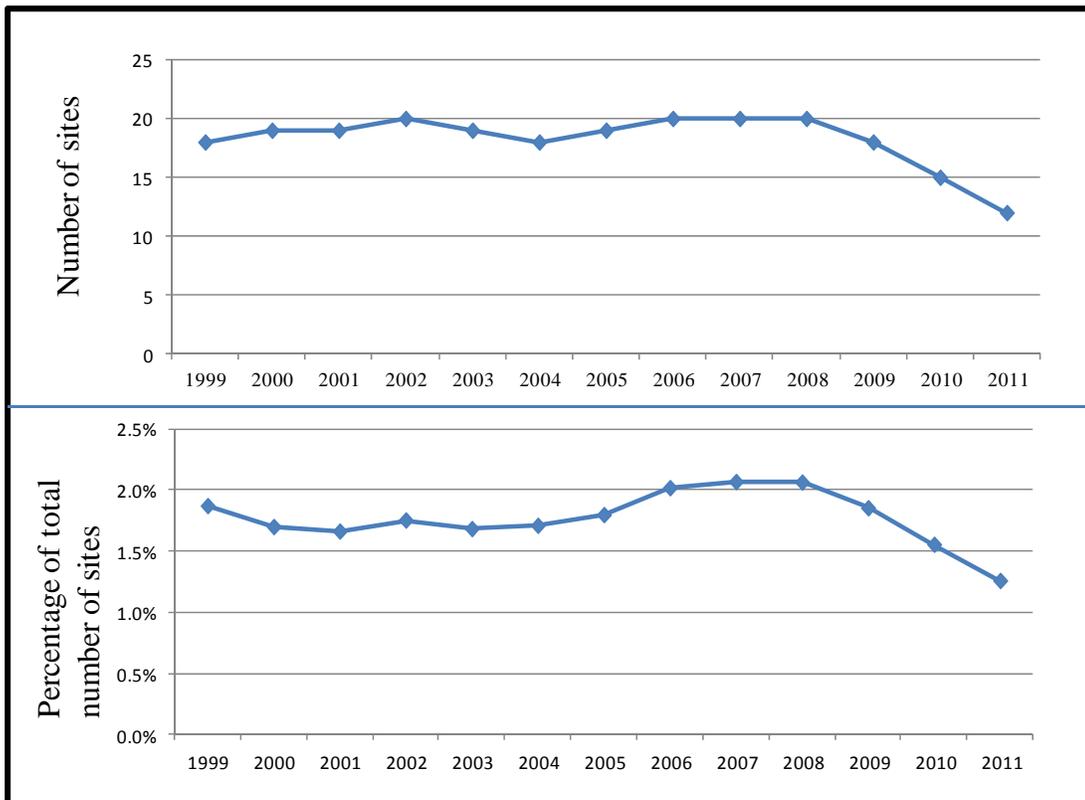


Figure 2 shows the number of sites, by year, approved for seasonal sampling, from 2008 to 2011, for which there is a collocated continuous FEM. Note that continuous FEMs did not come on-line until 2008. As seen in the figure, the number of seasonal sampling sites with a collocated continuous FEM has increased from none in 2008 to five in 2011.

Figure 2. Number of sites utilizing a seasonal sampling schedule and collocated with a continuous FEM, 2008-2011

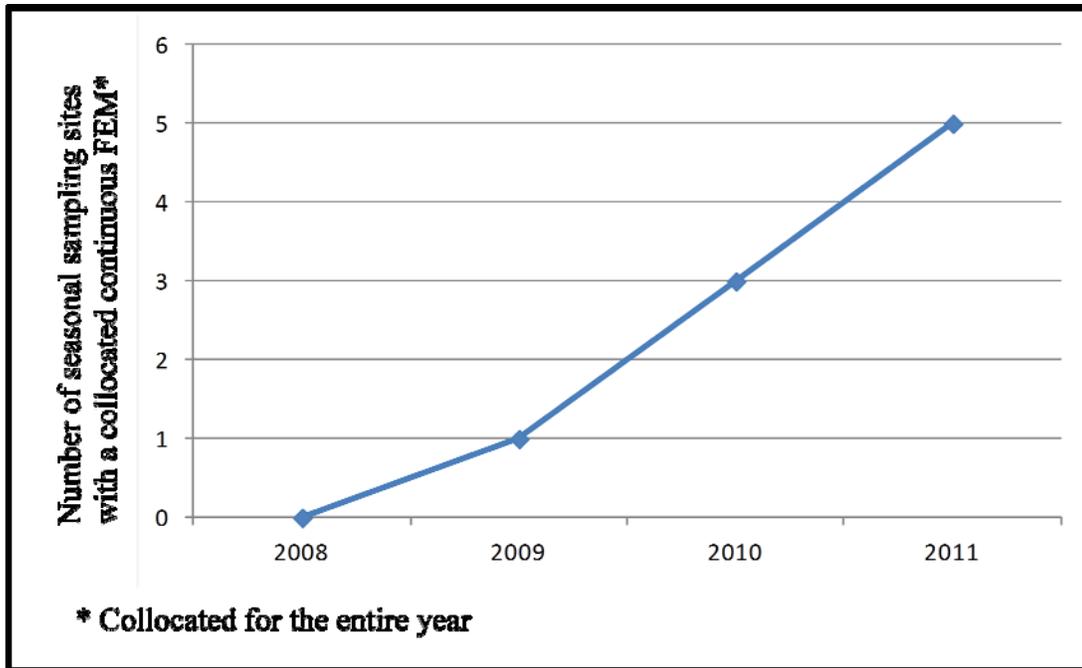


Table 1 (provided in Attachment 1) shows all the sites that used a seasonal sampling schedule from 1999 through 2011 and includes: the annual 98<sup>th</sup> percentiles identified as using the special seasonal sampling formula, corresponding annual 98<sup>th</sup> percentiles identified using the regular table-look-up procedure, 24-hour design values derived from seasonal-formula 98<sup>th</sup> percentiles, corresponding 24-hour design values derived from regular-formula 98<sup>th</sup> percentiles, and estimates of differences between the two methods. For this table, only years that contained at least 48 samples were included, and 24-hour design values are only shown if there were three consecutive years that met the annual criterion. The 98<sup>th</sup> percentiles and design values that exceed the 24-hour NAAQS level of 35 µg/m<sup>3</sup> are shaded. The differences between the results

of the two seasonal and regular methods are presented in two ways: 1) by concentration difference (in  $\mu\text{g}/\text{m}^3$ ) (e.g.,  $P98_{\text{seasonal}} - P98_{\text{regular}}$ ), and 2) by percentage difference (in %) (e.g.,  $((P98_{\text{seasonal}} / P98_{\text{regular}} - 1) * 100)$ ). As seen in the summary at the bottom of table 1, for the 210 site-year pairs, the seasonal-formula 98<sup>th</sup> percentiles were, on average, 3.9  $\mu\text{g}/\text{m}^3$  (8.2 %) lower than the corresponding regular-formula 98<sup>th</sup> percentiles. For the 164 site-level design value pairs, the 24-hour design values were, on average, 4.0  $\mu\text{g}/\text{m}^3$  (9.0 %) lower than the corresponding regular-formula design values. In the 1999-2011 timeframe, 21 of the 210 (10%) annual 98<sup>th</sup> percentile site-year pairs have a seasonal-formula 98<sup>th</sup> percentile that is equal or below the 24-hour NAAQS level but a corresponding regular-formula 98<sup>th</sup> percentile that exceeds it. In the same time period, 16 of the 164 (10%) design value pairs have a seasonal-formula 24-hour design value that meets the NAAQS but a corresponding regular-formula design value that does not meet it.

Table 2 (shown in Attachment 2) provides similar information as Table 1, but only for the most recent 3-year period (2009-2011). For this table, only sites that operated on a seasonal schedule for all three years are shown; all shown sites have valid 24-hour design values (per appendix N protocol) so the annual 98<sup>th</sup> percentiles are also considered valid. As in Table 1, 98<sup>th</sup> percentiles and design values that exceed the 24-hour NAAQS level of 35  $\mu\text{g}/\text{m}^3$  are shaded. 98<sup>th</sup> percentiles that are bolded in this table represent years for which the site had a collocated continuous FEM. For the 36 site-years shown for 2009-2011, the seasonal-formula 98<sup>th</sup> percentiles were, on average, 1.9  $\mu\text{g}/\text{m}^3$  (5.3 %) lower than the corresponding regular-formula 98<sup>th</sup> percentiles. For the 12 site-level design value pairs, the 24-hour design values were, on average, 1.8  $\mu\text{g}/\text{m}^3$  (5.4 %) lower than the corresponding regular-formula. The differences noted for the 2009-2011 period (for both 98<sup>th</sup> percentiles and 24-hour design values) are roughly one

half the levels noted for the 1999-2011 timeframe. In the 2009-2011 results, there are two annual 98<sup>th</sup> percentiles out of the 36 shown (6%) that have a seasonal-formula 98<sup>th</sup> percentile that is equal or below the 24-hour NAAQS level but a corresponding regular-formula 98<sup>th</sup> percentile that exceeds it. There are no instances in the 2009-2011 timeframe (i.e., 0 out of 12) for which the seasonal-formula 24-hour design value meets the NAAQS but the corresponding regular-formula design value shows a violation.

Figure 3 below plots the average annual percent difference, from 1999 through 2011 with a fitted polynomial trend line. It appears that the differences between the results of the two different methods for identifying annual 98<sup>th</sup> percentile concentrations began narrowing around 2006. As discussed above, the difference in the results from the two methods in the most recent 3-year period is noticeably smaller than the differences in the results between the two methods for 1999-2011.

The recent reduction in difference between the results from the two different methods for identifying annual 98<sup>th</sup> percentiles as well as the reduction in the percentage of sites that had a change in NAAQS compliance status based on the two approaches (i.e., where the seasonal formula yielded a NAAQS metric that met the 24-hour standard level), can likely be attributed, at least in part, to the 2006 monitoring requirements. As noted in the proposal, the Agency modified the monitoring requirement for areas with an FRM operating on a non-daily schedule such that, when the design values were within five percent of the 24-hour PM<sub>2.5</sub> NAAQS, those areas would be required to increase the frequency of sampling to every day (40 CFR 58.12(d)(1); 71 FR 61165, October 17, 2006; 71 FR 61249, October 17, 2006). As more FEMs are deployed, there will continue to be less need for seasonal sampling and thus, there will also be less need for a seasonal sampling adjustment.

Figure 3. Average percentage difference, by year, between 98<sup>th</sup> percentiles identified with the seasonal sampling procedure versus those identified with the regular table look-up procedure

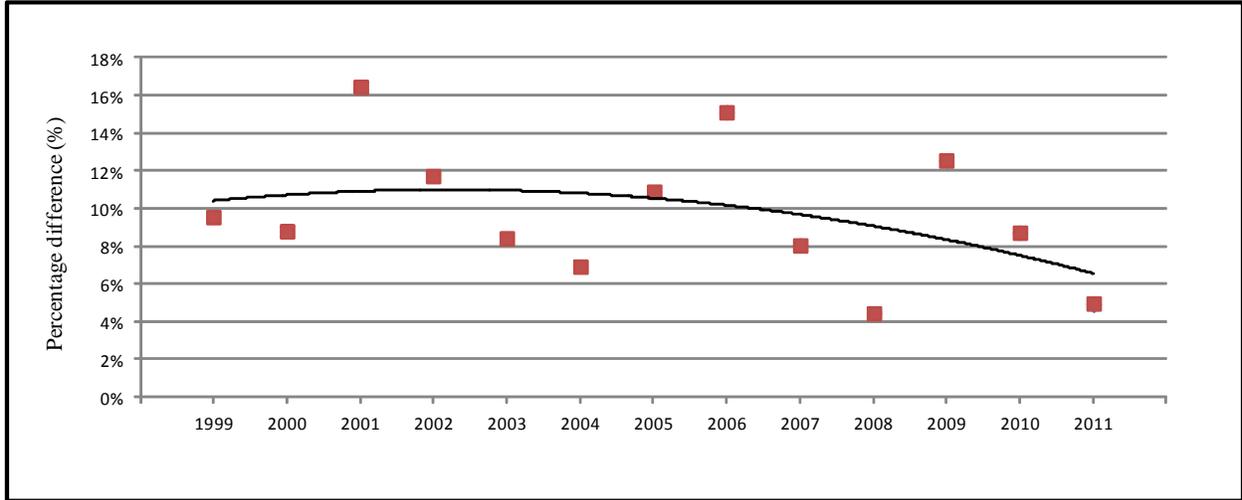


Table 1. Comparison of 98th percentiles (and associated 24-hour design values) derived via the special seasonal sampling formula versus those derived via the regular table look-up method, 1999-2011

SITE	Year	98th percentiles using special seasonal sampling formula, 1999-2011 (µg/m3)	98th percentiles using regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)	24-hour design values (shown on end year) using 98th percentiles derived by special seasonal sampling formula, 1999-2011 (µg/m3)	24-hour design values (shown on end year) using 98th percentiles derived by regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)
021100027	2003	5.7	5.7	0	0.0%				
060010007	2000	38.3	49.7	-11.4	-22.9%				
060010007	2001	57.1	77.7	-20.6	-26.5%				
060010007	2002	50.5	51.6	-1.1	-2.1%	49	60	-11	-18.3%
060010007	2003	24.2	27.1	-2.9	-10.7%	44	52	-8	-15.4%
060010007	2004	35.3	38.1	-2.8	-7.3%	37	39	-2	-5.1%
060010007	2005	28.7	29.2	-0.5	-1.7%	29	31	-2	-6.5%
060010007	2006	36.6	49.7	-13.1	-26.4%	34	39	-5	-12.8%
060010007	2007	39.2	49.2	-10	-20.3%	35	43	-8	-18.6%
060010007	2008	32.7	34.5	-1.8	-5.2%	36	44	-8	-18.2%
060010007	2009	30.7	33.6	-2.9	-8.6%	34	39	-5	-12.8%
060010007	2010	26.5	28.4	-1.9	-6.7%	30	32	-2	-6.3%
060010007	2011	27	27	0	0.0%	28	30	-2	-6.7%
060010009	2008	23.8	25.9	-2.1	-8.1%				
060010009	2009	24.5	24.7	-0.2	-0.8%				
060010009	2010	21.7	21.7	0	0.0%	23	24	-1	-4.2%
060010009	2011	28	28	0	0.0%	25	25	0	0.0%
060011001	1999	45.2	45.2	0	0.0%				
060011001	2000	36.3	42.2	-5.9	-14.0%				
060011001	2001	47	51	-4	-7.8%	43	46	-3	-6.5%
060011001	2002	41.5	44.2	-2.7	-6.1%	42	46	-4	-8.7%
060011001	2003	22.1	23.8	-1.7	-7.1%	37	40	-3	-7.5%
060011001	2004	33	37	-4	-10.8%	32	35	-3	-8.6%
060011001	2005	27.6	30.9	-3.3	-10.7%	28	31	-3	-9.7%
060011001	2006	30.4	39.7	-9.3	-23.4%	30	36	-6	-16.7%
060011001	2007	33.3	43.3	-10	-23.1%	30	38	-8	-21.1%
060011001	2008	22.7	27	-4.3	-15.9%	29	37	-8	-21.6%
060011001	2009	24.1	25.4	-1.3	-5.1%	27	32	-5	-15.6%
060011001	2010	22.5	22.5	0	0.0%	23	25	-2	-8.0%
060130002	1999	44.1	54.9	-10.8	-19.7%				
060130002	2000	44.8	45.8	-1	-2.2%				
060130002	2001	43.3	67.2	-23.9	-35.6%	44	56	-12	-21.4%
060130002	2002	57.3	63	-5.7	-9.0%	48	59	-11	-18.6%
060130002	2003	33.8	36.1	-2.3	-6.4%	45	55	-10	-18.2%
060130002	2004	38.1	42.5	-4.4	-10.4%	43	47	-4	-8.5%
060130002	2005	33.4	40.5	-7.1	-17.5%	35	40	-5	-12.5%
060130002	2006	33.6	38.5	-4.9	-12.7%	35	41	-6	-14.6%
060130002	2007	34.9	37.8	-2.9	-7.7%	34	39	-5	-12.8%
060130002	2008	35.2	31.1	4.1	13.2%	35	36	-1	-2.8%
060130002	2009	29.2	32.5	-3.3	-10.2%	33	34	-1	-2.9%
060130002	2010	26.8	30.9	-4.1	-13.3%	30	32	-2	-6.3%
060130002	2011	24.4	27.6	-3.2	-11.6%	27	30	-3	-10.0%
060195001	1999	59.2	83.2	-24	-28.8%				
060195001	2000	72.5	72.5	0	0.0%				
060195001	2001	71.5	76.2	-4.7	-6.2%	68	77	-9	-11.7%
060195001	2002	53.2	53.5	-0.3	-0.6%	66	67	-1	-1.5%
060195001	2003	48.1	48.4	-0.3	-0.6%	58	59	-1	-1.7%
060195001	2004	52.4	56	-3.6	-6.4%	51	53	-2	-3.8%
060195001	2005	63	67.1	-4.1	-6.1%	55	57	-2	-3.5%
060195001	2006	51.3	60.5	-9.2	-15.2%	56	61	-5	-8.2%
060195001	2007	60.9	61.2	-0.3	-0.5%	58	63	-5	-7.9%
060195001	2008	49	49.7	-0.7	-1.4%	54	57	-3	-5.3%
060195025	2000	64.8	65.1	-0.3	-0.5%				
060195025	2001	61.5	72.1	-10.6	-14.7%				
060195025	2002	71.9	73	-1.1	-1.5%	66	70	-4	-5.7%
060195025	2003	49.7	52	-2.3	-4.4%	61	66	-5	-7.6%

Table 1. Comparison of 98th percentiles (and associated 24-hour design values) derived via the special seasonal sampling formula versus those derived via the regular table look-up method, 1999-2011

SITE	Year	98th percentiles using special seasonal sampling formula, 1999-2011 (µg/m3)	98th percentiles using regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)	24-hour design values (shown on end year) using 98th percentiles derived by special seasonal sampling formula, 1999-2011 (µg/m3)	24-hour design values (shown on end year) using 98th percentiles derived by regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)
060195025	2004	49.4	52.1	-2.7	-5.2%	57	59	-2	-3.4%
060195025	2005	71.2	74.1	-2.9	-3.9%	57	59	-2	-3.4%
060195025	2006	55	65	-10	-15.4%	59	64	-5	-7.8%
060195025	2007	57.4	57.9	-0.5	-0.9%	61	66	-5	-7.6%
060195025	2008	44.5	46.4	-1.9	-4.1%	52	56	-4	-7.1%
060195025	2009	48.2	52.3	-4.1	-7.8%	50	52	-2	-3.8%
060195025	2010	37	40.2	-3.2	-8.0%	43	46	-3	-6.5%
060195025	2011	59.6	67.5	-7.9	-11.7%	48	53	-5	-9.4%
060231002	2006	21.5	25.7	-4.2	-16.3%				
060231002	2007	27.2	27.2	0	0.0%				
060231002	2008	21.5	21.5	0	0.0%	23	25	-2	-8.0%
060231002	2009	22.1	23.2	-1.1	-4.7%	24	24	0	0.0%
060231002	2010	15.8	17.4	-1.6	-9.2%	20	21	-1	-4.8%
060231002	2011	18.7	18.7	0	0.0%	19	20	-1	-5.0%
060231004	2007	21.8	23.5	-1.7	-7.2%				
060231004	2008	26	26.5	-0.5	-1.9%				
060231004	2009	23	24.2	-1.2	-5.0%	24	25	-1	-4.0%
060231004	2010	17.7	21.2	-3.5	-16.5%	22	24	-2	-8.3%
060231004	2011	23.7	23.7	0	0.0%	21	23	-2	-8.7%
060290010	1999	95.3	97.5	-2.2	-2.3%			0	
060290010	2000	93.9	102.5	-8.6	-8.4%			0	
060290010	2001	95.9	96.3	-0.4	-0.4%	95	99	-4	-4.0%
060290010	2002	80.4	81.6	-1.2	-1.5%	90	93	-3	-3.2%
060290010	2003	51.9	57.1	-5.2	-9.1%	76	78	-2	-2.6%
060290010	2004	53.9	54.6	-0.7	-1.3%	62	64	-2	-3.1%
060290010	2005	74.9	77.9	-3	-3.9%	60	63	-3	-4.8%
060290010	2006	64.4	75.2	-10.8	-14.4%	64	69	-5	-7.2%
060290010	2007	67.7	69.4	-1.7	-2.4%	69	74	-5	-6.8%
060290010	2008	60.8	60.9	-0.1	-0.2%	64	69	-5	-7.2%
060310004	1999	53	53	0	0.0%				
060310004	2000	55.1	55.1	0	0.0%				
060310004	2001	89.5	120.6	-31.1	-25.8%	66	76	-10	-13.2%
060310004	2002	65.1	77.4	-12.3	-15.9%	70	84	-14	-16.7%
060310004	2003	42.2	48.5	-6.3	-13.0%	66	82	-16	-19.5%
060310004	2004	49.4	49.6	-0.2	-0.4%	52	59	-7	-11.9%
060310004	2005	74.5	77.8	-3.3	-4.2%	55	59	-4	-6.8%
060310004	2006	50.1	63.8	-13.7	-21.5%	58	64	-6	-9.4%
060310004	2007	57.9	59.5	-1.6	-2.7%	61	67	-6	-9.0%
060310004	2008	47.9	47.9	0	0.0%	52	57	-5	-8.8%
060310004	2009	53.4	53.4	0	0.0%	53	54	-1	-1.9%
060310004	2010	46.8	47.2	-0.4	-0.8%	49	50	-1	-2.0%
060310004	2011	38.7	40.8	-2.1	-5.1%	46	47	-1	-2.1%
060472510	1999	91.9	91.9	0	0.0%				
060472510	2000	60	68.4	-8.4	-12.3%				
060472510	2001	49.3	49.3	0	0.0%	67	70	-3	-4.3%
060472510	2002	55.1	57.6	-2.5	-4.3%	55	58	-3	-5.2%
060472510	2003	44.2	44.7	-0.5	-1.1%	50	51	-1	-2.0%
060472510	2004	43	46.9	-3.9	-8.3%	47	50	-3	-6.0%
060472510	2005	48.3	48.6	-0.3	-0.6%	45	47	-2	-4.3%
060472510	2006	43.8	52.5	-8.7	-16.6%	45	49	-4	-8.2%
060472510	2007	52.7	53	-0.3	-0.6%	48	51	-3	-5.9%
060472510	2008	54	53.6	0.4	0.7%	50	53	-3	-5.7%
060472510	2009	45.2	49.8	-4.6	-9.2%	51	52	-1	-1.9%
060472510	2010	35.5	39.1	-3.6	-9.2%	45	48	-3	-6.3%
060472510	2011	35.4	38.5	-3.1	-8.1%	39	42	-3	-7.1%
060670006	1999	84	84	0	0.0%				

Table 1. Comparison of 98th percentiles (and associated 24-hour design values) derived via the special seasonal sampling formula versus those derived via the regular table look-up method, 1999-2011

SITE	Year	98th percentiles using special seasonal sampling formula, 1999-2011 (µg/m3)	98th percentiles using regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)	24-hour design values (shown on end year) using 98th percentiles derived by special seasonal sampling formula, 1999-2011 (µg/m3)	24-hour design values (shown on end year) using 98th percentiles derived by regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)
060670006	2000	84	81	3	3.7%				
060670006	2001	38	38	0	0.0%	69	68	1	1.5%
060670006	2002	62	66	-4	-6.1%	61	62	-1	-1.6%
060670006	2003	43	49	-6	-12.2%	48	51	-3	-5.9%
060670006	2004	42	45	-3	-6.7%	49	53	-4	-7.5%
060670006	2005	49	67	-18	-26.9%	45	54	-9	-16.7%
060670006	2006	55	58	-3	-5.2%	49	57	-8	-14.0%
060674001	1999	71	71	0	0.0%				
060674001	2000	50	58	-8	-13.8%				
060674001	2001	28	42	-14	-33.3%	50	57	-7	-12.3%
060674001	2002	60	62	-2	-3.2%	46	54	-8	-14.8%
060674001	2003	36	37	-1	-2.7%	41	47	-6	-12.8%
060674001	2004	35	36	-1	-2.8%	44	45	-1	-2.2%
060674001	2005	42	46	-4	-8.7%	38	40	-2	-5.0%
060674001	2006	39	40	-1	-2.5%	39	41	-2	-4.9%
060750005	1999	48.3	55.2	-6.9	-12.5%				
060750005	2000	35.3	39.7	-4.4	-11.1%				
060750005	2001	51.3	55.4	-4.1	-7.4%	45	50	-5	-10.0%
060750005	2002	57.5	66.2	-8.7	-13.1%	48	54	-6	-11.1%
060750005	2003	33	36.3	-3.3	-9.1%	47	53	-6	-11.3%
060750005	2004	32.2	36.1	-3.9	-10.8%	41	46	-5	-10.9%
060750005	2005	32.6	39.4	-6.8	-17.3%	33	37	-4	-10.8%
060750005	2006	27.8	32.7	-4.9	-15.0%	31	36	-5	-13.9%
060750005	2007	27.4	35.7	-8.3	-23.2%	29	36	-7	-19.4%
060750005	2008	23.8	26.8	-3	-11.2%	26	32	-6	-18.8%
060811001	1999	53.4	53.4	0	0.0%				
060811001	2000	43	44	-1	-2.3%				
060811001	2001	46.1	50.9	-4.8	-9.4%	48	49	-1	-2.0%
060811001	2002	36.3	37.8	-1.5	-4.0%	42	44	-2	-4.5%
060811001	2003	26.1	30.6	-4.5	-14.7%	36	40	-4	-10.0%
060811001	2004	27.9	29.1	-1.2	-4.1%	30	33	-3	-9.1%
060811001	2005	29.4	29.4	0	0.0%	28	30	-2	-6.7%
060811001	2006	30.9	34.8	-3.9	-11.2%	29	31	-2	-6.5%
060811001	2007	32.8	33	-0.2	-0.6%	31	32	-1	-3.1%
060811001	2008	24.3	26.8	-2.5	-9.3%	29	32	-3	-9.4%
060850004	1999	59.7	65.4	-5.7	-8.7%				
060850004	2000	55.3	56.6	-1.3	-2.3%				
060850004	2001	56.2	62.5	-6.3	-10.1%	57	62	-5	-8.1%
060850005	2002	46.7	52	-5.3	-10.2%				
060850005	2003	37.4	40.1	-2.7	-6.7%				
060850005	2004	39.8	42.7	-2.9	-6.8%	41	45	-4	-8.9%
060850005	2005	39.8	41.2	-1.4	-3.4%	39	41	-2	-4.9%
060850005	2006	36	42.8	-6.8	-15.9%	39	42	-3	-7.1%
060850005	2007	39.1	44.2	-5.1	-11.5%	38	43	-5	-11.6%
060850005	2008	32.4	36.3	-3.9	-10.7%	36	41	-5	-12.2%
060850005	2009	29.8	30.7	-0.9	-2.9%	34	37	-3	-8.1%
060850005	2010	29.2	33.3	-4.1	-12.3%	30	33	-3	-9.1%
060850005	2011	30.5	34.2	-3.7	-10.8%	30	33	-3	-9.1%
060852003	1999	63.2	66.9	-3.7	-5.5%				
060852003	2000	54.5	60	-5.5	-9.2%				
060852003	2001	49.7	57.2	-7.5	-13.1%	56	61	-5	-8.2%
060852003	2002	37.3	43.7	-6.4	-14.6%	47	54	-7	-13.0%
060852003	2003	32.5	37	-4.5	-12.2%	40	46	-6	-13.0%
060852003	2004	36.5	37.9	-1.4	-3.7%	35	40	-5	-12.5%
060852003	2005	38.7	40.9	-2.2	-5.4%	36	39	-3	-7.7%
060852003	2006	23.8	25.6	-1.8	-7.0%	33	35	-2	-5.7%

Table 1. Comparison of 98th percentiles (and associated 24-hour design values) derived via the special seasonal sampling formula versus those derived via the regular table look-up method, 1999-2011

SITE	Year	98th percentiles using special seasonal sampling formula, 1999-2011 (µg/m3)	98th percentiles using regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)	24-hour design values (shown on end year) using 98th percentiles derived by special seasonal sampling formula, 1999-2011 (µg/m3)	24-hour design values (shown on end year) using 98th percentiles derived by regular table look-up method, 1999-2011 (µg/m3)	Difference between the two estimates (µg/m3)	Difference between the two estimates as a percent of the regular method estimate (%)
060950004	1999	52.3	52.3	0	0.0%				
060950004	2000	44	60.1	-16.1	-26.8%				
060950004	2001	56	78	-22	-28.2%	51	63	-12	-19.0%
060950004	2002	55.4	71.2	-15.8	-22.2%	52	70	-18	-25.7%
060950004	2003	25.1	27.3	-2.2	-8.1%	46	59	-13	-22.0%
060950004	2004	36.9	38.6	-1.7	-4.4%	39	46	-7	-15.2%
060950004	2005	35.6	41	-5.4	-13.2%	33	36	-3	-8.3%
060950004	2006	34.3	40.5	-6.2	-15.3%	36	40	-4	-10.0%
060950004	2007	38.6	40	-1.4	-3.5%	36	41	-5	-12.2%
060950004	2008	36.3	40.5	-4.2	-10.4%	36	40	-4	-10.0%
060950004	2009	33.5	37.1	-3.6	-9.7%	36	39	-3	-7.7%
060950004	2010	22.8	25.5	-2.7	-10.6%	31	34	-3	-8.8%
060970003	1999	44.5	44.5	0	0.0%				
060970003	2000	36.8	39.5	-2.7	-6.8%				
060970003	2001	41.4	41.9	-0.5	-1.2%	41	42	-1	-2.4%
060970003	2002	42.4	47.4	-5	-10.5%	40	43	-3	-7.0%
060970003	2003	29.8	30.8	-1	-3.2%	38	40	-2	-5.0%
060970003	2004	25.2	25.2	0	0.0%	32	34	-2	-5.9%
060970003	2005	29.7	32.6	-2.9	-8.9%	28	30	-2	-6.7%
060970003	2006	31.2	32.4	-1.2	-3.7%	29	30	-1	-3.3%
060970003	2007	30.2	30.5	-0.3	-1.0%	30	32	-2	-6.3%
060970003	2008	29.8	29.8	0	0.0%	30	31	-1	-3.2%
060970003	2009	25.2	25.9	-0.7	-2.7%	28	29	-1	-3.4%
060970003	2010	22.2	22.2	0	0.0%	26	26	0	0.0%
060970003	2011	23.4	23.4	0	0.0%	24	24	0	0.0%
230052003	1999	23	33.3	-10.3	-30.9%				
230052003	2000	21.1	21.1	0	0.0%				
230052003	2001	28.3	28.9	-0.6	-2.1%				
230052003	2002	25.8	25.9	-0.1	-0.4%	25	25	0	0.0%
230090103	1999	17.1	20.6	-3.5	-17.0%				
230090103	2000	13.5	13.5	0	0.0%				
230090103	2001	28.2	28.2	0	0.0%	20	21	-1	-4.8%
230090103	2002	25.9	43.3	-17.4	-40.2%	23	28	-5	-17.9%
230090103	2003	21.8	25.4	-3.6	-14.2%	25	32	-7	-21.9%
230090103	2004	18.7	22.6	-3.9	-17.3%	22	30	-8	-26.7%
230090103	2005	18.7	24.2	-5.5	-22.7%	20	24	-4	-16.7%
230090103	2006	19.9	19.9	0	0.0%	19	22	-3	-13.6%
230090103	2007	19.8	21.6	-1.8	-8.3%	19	22	-3	-13.6%
230090103	2008	18.6	18.6	0	0.0%	19	20	-1	-5.0%
230090103	2009	10.1	19.3	-9.2	-47.7%	16	20	-4	-20.0%
230090103	2010	16.2	18.7	-2.5	-13.4%	15	19	-4	-21.1%
230090103	2011	12.6	12.8	-0.2	-1.6%	13	17	-4	-23.5%
count		210	210	210	210	164	164	164	164
average		41.1	45.0	-3.9	-8.2%	41	45	-4.0	-9.0%
median		37.7	42.0	-2.7	-6.7%	39	43	-3	-7.9%
Number of annual 98th percentiles that are above the 24-hour NAAQS level (35 µg/m3) using the regular formula but equal/below the NAAQS level using the seasonal formula					21	Number of DVs that violate the 24-hour NAAQS (35 µg/m3) using the regular formula but meet the NAAQS using the seasonal formula			16

Note. 98th percentiles and design values that are shaded exceed the 24-hour NAAQS level of 35 µg/m3

Table 2. Comparison of 98th percentiles (and associated 24-hour design values) derived via the special seasonal sampling formula versus those derived via the regular table look-up method, 2009-2011

Site	98th percentiles and 24-hour design values using special seasonal sampling formula, 2009-2011 (µg/m3)				98th percentiles and 24-hour design values using regular table look-up method, 2009-2011 (µg/m3)			
	98th 2009	98th 2010	98th 2011	DV 2009-2011	98th 2009	98th 2010	98th 2011	DV 2009-2011
060010007	30.7	26.5	<b>27.0</b>	28	33.6	28.4	<b>27.0</b>	30
060010009	24.7	<b>21.7</b>	<b>28.0</b>	25	24.7	<b>21.7</b>	<b>28.0</b>	25
060130002	29.2	26.8	24.4	27	32.5	30.9	27.6	30
060195025	<b>48.2</b>	<b>37.0</b>	<b>59.6</b>	<b>48</b>	<b>52.3</b>	<b>40.2</b>	<b>67.5</b>	<b>53</b>
060231002	22.1	15.8	18.7	19	23.2	17.4	18.7	20
060231004	23.0	17.7	23.7	21	24.2	21.2	23.7	23
060310004	<b>53.4</b>	<b>46.8</b>	<b>38.7</b>	<b>46</b>	<b>53.4</b>	<b>47.2</b>	<b>40.8</b>	<b>47</b>
060472510	<b>45.2</b>	<b>35.5</b>	35.4	<b>39</b>	<b>49.8</b>	<b>39.1</b>	<b>38.5</b>	<b>42</b>
060850005	29.8	29.2	30.5	30	30.7	33.3	34.2	33
060950004	33.5	22.8	<b>31.0</b>	29	<b>37.1</b>	25.5	<b>31.0</b>	31
060970003	25.9	<b>22.2</b>	<b>23.4</b>	24	25.9	<b>22.2</b>	<b>23.4</b>	24
230090103	10.1	16.2	12.6	13	10.1	16.2	12.6	13

- Notes: 1. 98th percentiles that are bolded represent years for which there was a collocated FEM at the site.  
 2. 98th percentiles and design values that are shaded exceed the 24-hour NAAQS level of 35 µg/m3.

Site	Difference in 98th percentiles and 24-hour design values between the two methods, in µg/m3			
	98th 2009	98th 2010	98th 2011	DV 2009-2011
060010007	-2.9	-1.9	<b>0.0</b>	-2.0
060010009	0.0	<b>0.0</b>	<b>0.0</b>	0.0
060130002	-3.3	-4.1	-3.2	-3.0
060195025	-4.1	-3.2	-7.9	-5.0
060231002	-1.1	-1.6	0.0	-1.0
060231004	-1.2	-3.5	0.0	-2.0
060310004	<b>0.0</b>	<b>-0.4</b>	<b>-2.1</b>	-1.0
060472510	-4.6	-3.6	-3.1	-3.0
060850005	-0.9	-4.1	-3.7	-3.0
060950004	-3.6	-2.7	<b>0.0</b>	-2.0
060970003	0.0	<b>0.0</b>	<b>0.0</b>	0.0
230090103	0.0	0.0	0.0	0.0
	<u>98th 2009</u>	<u>98th 2010</u>	<u>98th 2011</u>	<u>DV 2009-2011</u>
average	-1.8	-2.1	-1.7	-1.8
median	-1.2	-2.3	0.0	-2.0

Difference in 98th percentiles and 24-hour design values between the two methods, as a % of the regular method value			
98th 2009	98th 2010	98th 2011	DV 2009-2011
-8.6%	-6.7%	<b>0.0%</b>	-6.7%
0.0%	<b>0.0%</b>	<b>0.0%</b>	0.0%
-10.2%	-13.3%	-11.6%	-10.0%
-7.8%	-8.0%	-11.7%	-9.4%
-4.7%	-9.2%	0.0%	-5.0%
-5.0%	-16.5%	0.0%	-8.7%
<b>0.0%</b>	<b>-0.8%</b>	<b>-5.1%</b>	-2.1%
-9.2%	-9.2%	-8.1%	-7.1%
-2.9%	-12.3%	-10.8%	-9.1%
-9.7%	-10.6%	<b>0.0%</b>	-6.5%
0.0%	<b>0.0%</b>	<b>0.0%</b>	0.0%
0.0%	0.0%	0.0%	0.0%
	<u>98th 2009</u>	<u>98th 2010</u>	<u>98th 2011</u>
average	-4.8%	-7.2%	-3.9%
median	-4.9%	-8.6%	0.0%

Avg. difference in all (36) 98th percentiles (µg/m3)	-1.9
Median difference in all (36) 98th percentiles (µg/m3)	-1.6

Avg. diff. in all 98th %iles (percent of regular value)	-5.3%
Median diff. in all 98th %iles (percent of regular value)	-5.1%

Avg. difference in the 27 98th percentiles for which the sites didn't have a collocated FEM (µg/m3)	-2.4
Median difference in the 27 98th percentiles for which the sites didn't have a collocated FEM (µg/m3)	-2.9

Avg. difference in the 27 98th percentiles for which the sites didn't have a collocated FEM (percentage)	-6.9%
Median difference in the 27 98th percentiles for which the sites didn't have a collocated FEM (percent)	-8.1%

Number of annual 98th percentiles that are above the 24-hour NAAQS level (35)	2
Number of design values that are above the 24-hour NAAQS level (35 µg/m3)	0