# Natural Events Policy Documentation of a Natural Event Due to High Winds on 5-Mar-2003 Kennewick, WA

## Benton Clean Air Authority

May 4, 2004

## OVERVIEW

On 5-Mar-2003 an exceedance of the primary 24-hour $PM_{10}$ National Ambient Air Quality Standard (NAAQS) was recorded at Kennewick, WA. $PM_{10}$ State/Local Air Monitoring Site (SLAMS). The concentration was officially reported as 186 µg/m³ at standard atmospheric conditions. The primary contributor to the exceedance was identified as fallowed and planted wheat fields, vulnerable irrigated agricultural fields, and to a lesser extent, localized urban areas, which were subjected to high wind speeds. An exact quantification of the source contributions is not available. The Benton Clean Air Authority (BCAA) believes that the 5-Mar-2003 event is a "natural event" in accordance with the EPA Natural Events Policy.

## NATURAL EVENTS POLICY

The Natural Events Policy (NEP) was issued in May 1996 to provide an avenue of response to $PM_{10}$ air quality data that are due to uncontrollable natural events. Under NEP provisions, $PM_{10}$ attributable to a natural event can be excluded from an attainment or non-attainment decision. The NEP is applicable when $PM_{10}$ data is due to uncontrollable natural events and the dust originates from non-anthropogenic sources or from contributing anthropogenic sources controlled with best available control measures (BACM)

The two basic requirements of the NEP are:

1) The states must develop a Natural Events Action Plan (NEAP) to deal with future $PM_{10}$ NAAQS exceedances.

2) The states must also establish a clear and casual relationship between the observed natural event and the observed exceedance and document the event.

## WASHINGTON STATE'S COLUMBIA PLATEAU WINDBLOWN DUST NATURAL EVENTS ACTION PLAN

Washington State's Natural Events Action Plan (NEAP) to address $PM_{10}$ from natural events occurring in the Columbia Plateau region of eastern Washington was a result of a large number of $PM_{10}$ NAAQS exceedances in this region in the period from the late 1980's and early 1990's. Agricultural fields upwind of $PM_{10}$ monitoring sites were identified as the principal sources of windblown dust. The Washington State Department of Ecology's Air Program division developed the initial NEAP in 1998 and updated the document in 2003.

The NEAP has several purposes:

- Development of procedures for taking appropriate, reasonable measures to safeguard public health when natural events occur.
- Responsibility to assure that emission controls are applied to sources that contribute to exceedances of the $PM_{10}$ NAAQS, when those controls will result in fewer violations of the standards. Emission controls include BACM development and implementation.
- Authorization for documentation to be submitted to request designation of an exceedance of the NAAQS for $PM_{10}$ as being the result of a natural event.

**Definition of High Wind Event in NEAP**

The 2003 NEAP refined the definition of high wind event for Washington State in accordance with the provisions of the NEP allowing the states to determine this definition. This provision recognizes the multiple variables that affect the wind erosion processes that result in windblown dust and the generation and transport of $PM_{10}$, which geographically differs. Following is the definition of a "high wind event" from pages A1-A4 of the Washington State Columbia Plateau Windblown Dust Natural Events Action Plan (Ref 12):

*"A high wind event occurs when the wind entrains and suspends dust to the extent that concentrations of $PM_{10}$ are elevated. This occurs when the average hourly wind speed at 10m is 18 miles per hour or greater for two or more hours [18+2]; or in excess of 13 [13+2] miles per hour for two or more hours when conditions of higher susceptibility to wind erosion exist (see attachment A1). A high wind event that exceeds $PM_{10}$ standard is a natural event."*

This definition recognizes the concept that the wind speed threshold for wind erosive processes on soil to cause elevated $PM_{10}$ concentrations in the air is variable. This variability depends on multiple variables related to soil characteristics, wind gustiness, soil surface residue cover, moisture content, and others. Attachment A1 to the Appendix A and of the Columbia Plateau NEAP documents the research and explains the logic behind this two-stage "high wind event" definition. The high wind event definition also necessarily includes the concept that the intensity of the wind event is a combination of wind speed and significant duration (sustained wind).

<u>Relationship of High Wind Event Definition to Documentation</u>

The amount of detail in the event documentation required by the NEAP varies with the category (18 mph for ≥ 2 hr; or 13 mph for ≥ 2 hr under higher wind erosion susceptibility) of high wind event definition. For the "18 + 2" category the documentation burden is less because of the more clear-cut association of the observed $PM_{10}$ data and the wind speed profile. The wind speed profile contains wind speed, wind direction, and duration and essentially is a data plot of wind speed and direction against a period of time. Precipitation preceding the day of the event is also part the “18 + 2” data set. The higher wind speed event more easily meets the “clear and casual” criteria of the Natural Events Policy.

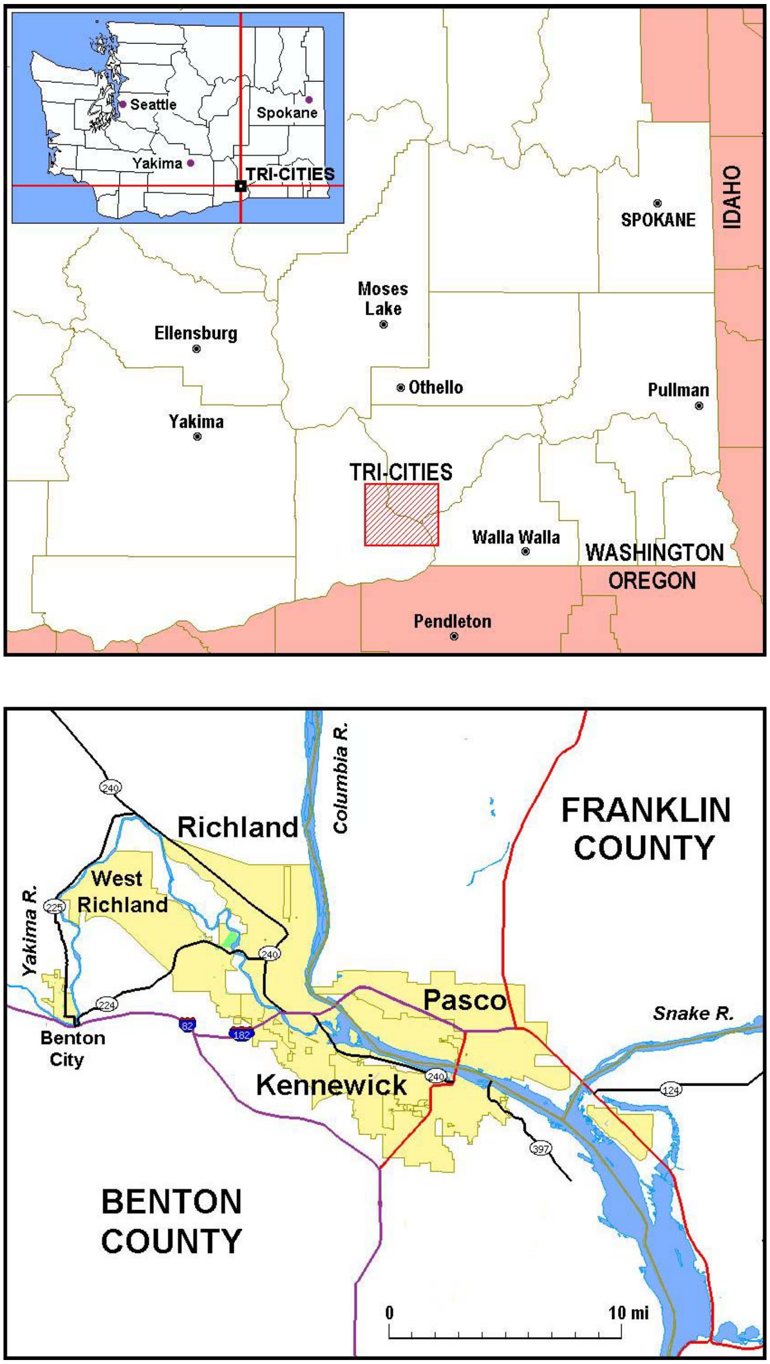
The “13 + 2” category within the high wind event definition is more complex with respect to establishing the link between the wind event and elevated $PM_{10}$. The meteorological phenomena driving the process are spatially and temporally more complex and the number, geographic distribution and complexity of the meteorological measurements needed to describe the event are greater. These complexities may require more sophisticated methodology to reveal the dynamics of the event. Regional scale meteorological modeling coupled with $PM_{10}$ generation (emission) and transport modeling may be necessary and other data may be needed to link an event to remote source areas.

## GENERAL DESCRIPTION OF AREA

Kennewick, Richland (including West Richland), and Pasco, known collectively as the Tri-Cities, are located in southeast Washington where the Yakima, Columbia, and Snake Rivers meet (Figure 1). The eastern half of the State of Washington lies in the rain shadow of the Cascade Mountains making the region a semi-arid desert. Average annual precipitation in the Tri-Cities region is about 6-7 inches with high rainfall intensity being very uncommon. Irrigated agriculture produces a wide diversity of crops including fruits, vegetables, alfalfa and potatoes. Dryland (non-irrigated) wheat production compliments the irrigated cropping systems. Large areas of non-agricultural range and desert lands complete the major land use areas of the region.

The Tri-Cities are located in an open-ended river basin partially bounded by low hills to the south and southwest. The terrain coupled with prevailing south and west winds limit local stagnant air pollution by ventilating the area. This coupling can also produce some extraordinary wind speeds and patterns. These winds can produce significant wind erosion events that can blanket the Tri-Cities region with dust from vulnerable agricultural fields and other areas. On rare occasions, usually during the fall and winter, strong winds can occur from the north and northwest sectors.

Figure 1: The Tri-Cities Area



## EVALUATION OF 5-MAR-2003 EVENT

This section describes the major factors that affected the occurrence of the windblown dust event and an exceedance of the $PM_{10}$ NAAQS on 5-Mar-2003 in Kennewick, WA. An overview of the $PM_{10}$ data in several months previous to and after the wind event shows the relatively infrequent occurrence of windblown exceedances. Analysis of the high wind event uses the “18 + 2” classification and summarizes the circumstances and characteristics of the event. Best available control measures (BACM) are assessed to demonstrate compliance with the BACM requirement of the Natural Events Policy. Landscape stability conditions are described to show what factors on the land and the activities taking place contributed to the observed windblown dust $PM_{10}$ NAAQS exceedance.

### $PM_{10}$ Data

The Kennewick $PM_{10}$ federal reference method (FRM) monitor operates on a 1- in - 1 day schedule. Tables A1 and A2 in Appendix A shows Kennewick $PM_{10}$ data for 2002 and data for January through March 2003, respectively. The average $PM_{10}$ concentration for 2002 was 23.3 ug/m$^3$. The average $PM_{10}$ concentration in the months prior to the 5-Mar-2003 exceedance was 10.4 ug/m$^3$ in January 2003 and 16.3 ug/m$^3$ in February 2003. These daily $PM_{10}$ values in Tables A1 and A2 (Appendix A) show that the days with 24-Hour $PM_{10}$ concentrations that exceed the NAAQS are rare and are much higher than the majority of daily values and other maximums for the period. The annual average $PM_{10}$ concentration has not exceeded the annual NAAQS standard of 50 ug/m$^3$ in 18 years of monitoring at the Kennewick site.

Table 1 shows the occurrence of windblown $PM_{10}$ exceedances, which have been documented as natural events since the inception of the NEP in may 1996. The BCAA takes principal responsibility for high wind events and natural events documentation for exceedances that affect primarily Benton County. Documentation of larger regional events that affect a greater area of the Columbia plateau including Benton County is the principal responsibility of the Washington State Department of Ecology's Air Program.

**Table 1: History of Documented Windblown Dust Natural Events in Benton County (BCAA jurisdiction)**

| YEAR | DATE | CONCENTRATION μg/m3 | ACTION TAKEN |
|---|---|---|---|
| 1999 | September 23 | 180 | Ecology NEP[1] |
| 1999 | September 25 | 305 | Ecology NEP[1] |
| 2000 | July 31 | 218 | BCAA NEP[2] |
| 2001 | March 13 | 351 | BCAA NEP[2] |
| 2001 | September 25 | 284 | Ecology NEP[1] |
| 2001 | October 23 | 267 | BCAA NEP[2] |
| 2002 | August 16 | 186 | BCAA NEP Pending |

[1] Regional event with generalized dust storm conditions from a high wind event occurring in the intermountain region east of the Cascade Mountain range, which are documented by the Washington State Department of Ecology's Air Program.

[2] Dust storm conditions from a high wind event that affected primarily Benton County documented by the Benton Clean Air Authority

## High Wind Event Analysis

Synoptic Weather Pattern

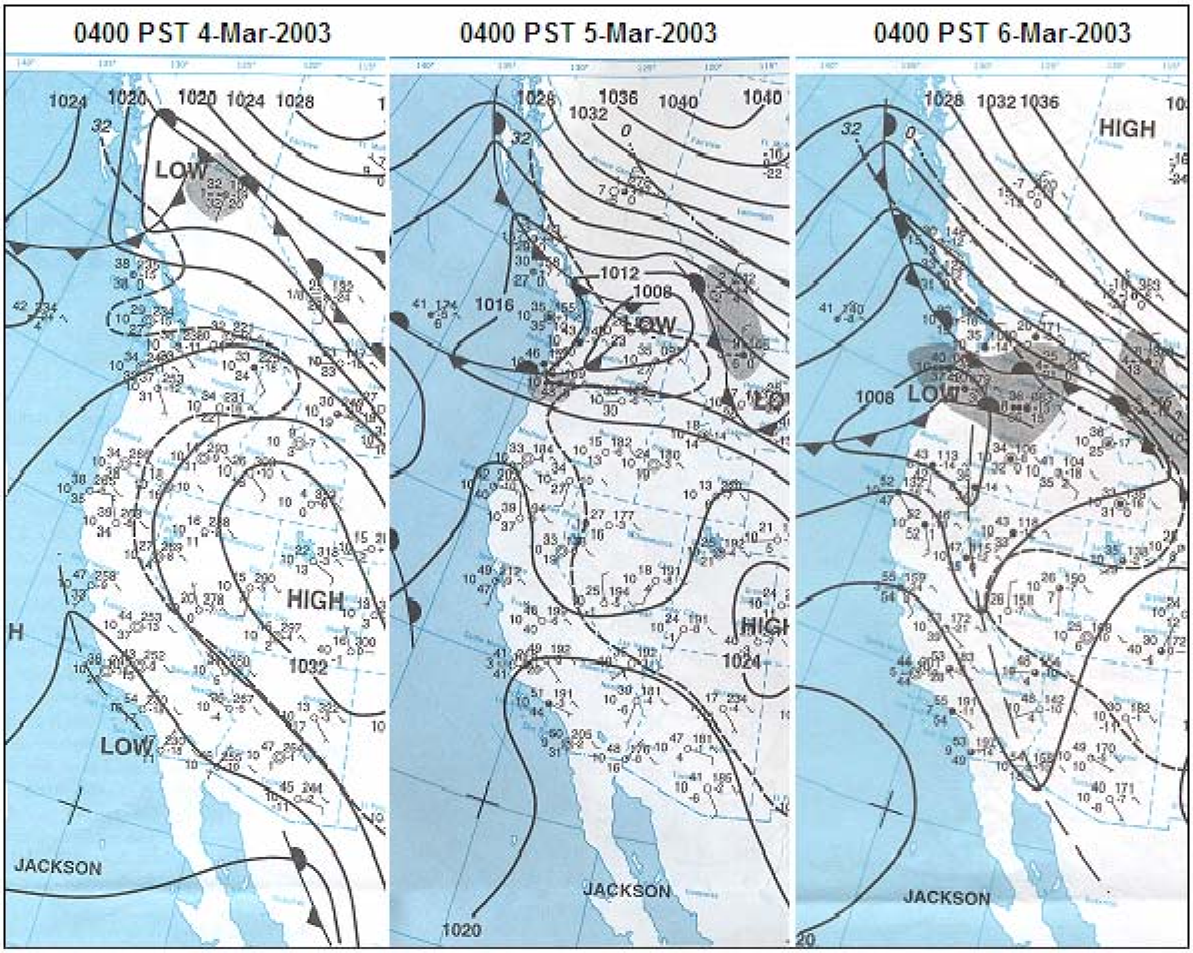
The synoptic weather pattern provides the broad view of the weather systems that set up and drive the observed wind event. The positioning of high and low pressure areas with associated air mass circulation patterns and pressure gradients help in understanding the wind speeds, direction, duration, and shifting of winds that may occur during a wind event.

Figure 2a shows that at 0400 PST on 4-Mar-2003, a well-developed low-pressure system was located north northwest of Washington State over British Columbia and was moving in a southeast direction towards Washington State. The system had already begun to have effects on the local weather in the Tri-Cities as wind speeds throughout the region began to increase. In many rural areas of Benton County wind speeds were approaching 20 mph by 0200 (PST) on 5-Mar-2003. In addition, this low-pressure system had been flanked to the south by a high-pressure system centered southeast of Washington in Utah.

In this configuration, with a low-pressure system to the northwest of a high-pressure system, a strong pressure gradient was established across Washington State. Because winds move from areas of higher pressure to lower pressure and the mass air movements are respectively counterclockwise and clockwise around lows and highs, strong winds were blowing from the southwest towards the northeast. During the course of the day, the high-pressure system pushed closer to the low, intensifying and combining with a pressure gradient over Montana (Figure 2b). The resulting wind speeds were high enough to cause soil particles to become airborne and generate $PM_{10}$ emissions. These high, sustained winds continued until about 0100 PST on 6-Mar-2003. By early 6-Mar-2003, the low-pressure system had become more established across most of the western U.S. (Figure 2c).

Figure 2 a-c: Synoptic Weather Maps

Figure 2a: Figure 2b: Figure 2c:




To show more detail about the wind pattern in the main dust source area, the data were examined from selected rural MET stations (colored red) and selected urban MET stations (blue colored) shown in figure 4a. The rural data shown in table 2 and the urban data is shown in table 3. Dust generated near the rural MET stations could easily be transported to the urban area and measured at the Kennewick $PM_{10}$ SLAMS as the speed, duration, and direction were sufficient for such transport. The location of these rural MET stations vary from 15 to 30 miles from the Kennewick monitor, easily within well-documented wind runs for transport of $PM_{10.}$ Urban fugitive also contributed to the exceedance.

As described, the necessary and sufficient conditions for wind conditions occurred on 5-Mar-2003 to cause an exceedance of the $PM_{10}$ NAAQS at the Kennewick monitoring station in the Tri-Cities. Since there are many irrigated and dryland fields that are located relatively close to the Kennewick monitoring site (within 5-40 miles), the wind speeds and duration necessary to transport dust from the fields to the population center are relatively low. This close proximity of agricultural fields to the populated areas (and the $PM_{10}$ SLAMS) makes the Tri-Cities distinct from other agricultural windblown dust situations, which typically have more remotely located source areas.

Direct Observational Information on the High Wind Event

The arid climate in the wheat-producing land in the areas of the Horse Heaven Hills makes fallow farming a necessary water harvesting method. In the fallow system, one-half the land is allowed to collect a year's amount of precipitation without growing wheat plants on that land. The other half of the land has actively growing wheat, which is using the moisture collected in the previous year's fallow land plus the current year's precipitation.

The exposed soils in fallow areas were potentially susceptible to wind erosion on 5-Mar-2003. The degree of susceptibility depended on the dryland wheat yields in the previous year, which determines the amount of straw residue available for holding the soil against the wind. The overall contribution from just-planted areas would also vary according to available surface residue left on the surface after planting. The landscape stability of the rural $PM_{10}$ source area on 5-Mar-2003 was sufficiently low to allow wind erosion with the combined effects of below-normal antecedent precipitation and necessary agricultural operations disturbing the soil.

Photos taken by BCAA staff on the Horse Heaven Hills dryland agricultural areas illustrate differing landscape stabilities against the wind (Figure 5). These photos were taken the day following the 5-Mar-2003 exceedance but no precipitation had occurred and field conditions that affect landscape stability had not changed. Wind conditions and the wind profiles were similar on 6-Mar-2003. Note that the $PM_{10}$ data for 6-Mar-2003 in Table A2 (Appendix A) showed a near exceedance at 126 $\mu g/m^3$.

Recently planted spring wheat fields were vulnerable because crop cover was not sufficient to decrease wind speed at the soil surface below wind erosion threshold speeds and were subject to wind erosion and $PM_{10}$ emissions. Sustained winds blowing across these unprotected and unstabilized soil surfaces cause soil particles to become airborne and transported into the Tri-Cities urban area even when BACM and BMP are being used (Figure 4a). Planted wheat fields where seedlings were emerging very sporadically across the field didn't prevent the soil from blowing (Figure 4b). The saltation creep effect was clearly seen in several areas, as a number of the fields that were blowing were being impacted by the blowing dust and the movement of soil from adjacent fields. Fallow fields with sufficient residue from previous wheat harvest were also being subjected to high wind speeds. Wheat fields with good residue whether fall-seeded, spring-seeded, or fallowed fields on 5-Mar-2003 were holding very well and exhibited little or no soil movement.

Windblown dust can come from construction sites at wind speeds substantially less than that needed to generate and transport dust from the agricultural areas to the urban areas. Based primarily upon direct observational evidence by BCAA staff and generally confirmed by the BCAA complaint records, often wind speeds of 5-10 mph can produce dust from extremely disturbed and vulnerable soil surfaces present on construction sites. On construction sites in and around the urban areas, extreme soil disturbance, an almost total lack of vegetative residue, and frequent mechanical activity make these construction sites vulnerable to wind erosion. On 5-Mar-2003, construction site dust may have contributed somewhat, but the data and our observations show that dust from agricultural areas was the dominant contributor.

Figure 3a: Irrigated and Dryland Agriculture PAWS Weather Stations of the Rural Area of Benton County 5-Mar-2003.

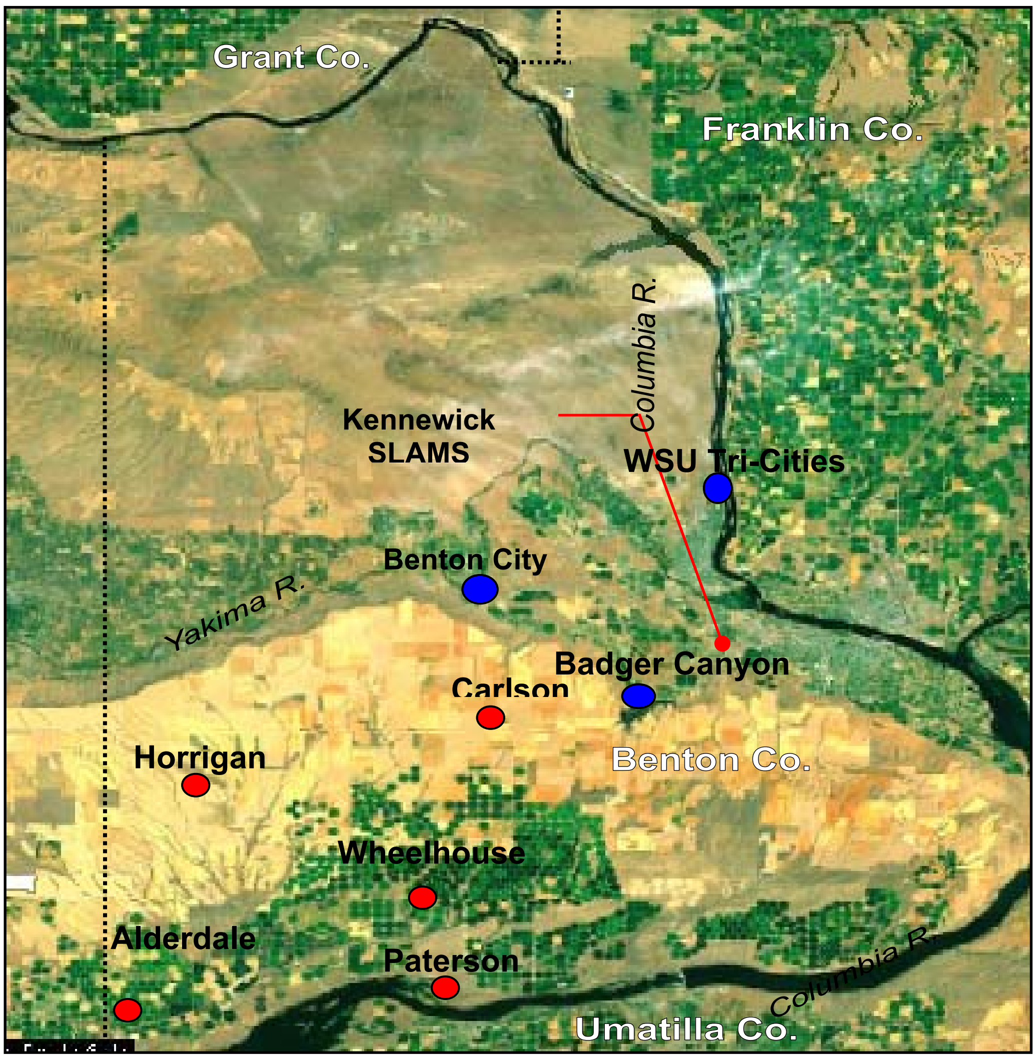


Table 2: Wind data from rural PAWS stations

| | Alderdale | | Horrigan | | Wheelhouse | | Carlson | | Paterson | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) |
| 0 | 17.90 | 258.400 | 18.81 | 249.600 | 14.42 | 237.000 | 6.87 | 183 | 6.96 | 214.600 |
| 1 | 12.08 | 243.900 | 3.44 | 193.600 | 4.15 | 223.400 | 8.14 | 194.3 | 8.22 | 244.000 |
| 2 | 12.18 | 242.100 | 4.52 | 212.500 | 5.80 | 218.200 | 11.23 | 209.9 | 16.51 | 235.600 |
| 3 | 13.28 | 234.900 | 1.23 | 226.600 | 8.25 | 229.000 | 11.23 | 209.3 | 13.18 | 227.900 |
| 4 | 12.65 | 245.100 | 2.15 | 253.800 | 10.95 | 224.700 | 9.7 | 204.8 | 18.81 | 230.000 |
| 5 | 21.72 | 253.800 | 4.54 | 193.900 | 16.44 | 230.600 | 12.44 | 221.9 | 17.72 | 240.000 |
| 6 | 16.80 | 247.600 | 13.49 | 233.200 | 11.38 | 232.100 | 16.53 | 225.9 | 17.49 | 233.400 |
| 7 | 18.23 | 248.900 | 15.90 | 223.000 | 13.08 | 225.300 | 17.16 | 220.2 | 13.53 | 218.400 |
| 8 | 17.22 | 243.700 | 18.99 | 225.700 | 18.12 | 233.900 | 19.86 | 221.5 | 11.99 | 219.100 |
| 9 | 14.58 | 229.500 | 23.26 | 219.400 | 24.88 | 231.500 | 27.67 | 224.2 | 19.42 | 225.800 |
| 10 | 23.56 | 240.200 | 24.72 | 213.700 | 28.57 | 224.000 | 29.93 | 218.1 | 27.78 | 240.900 |
| 11 | 25.26 | 245.900 | 23.24 | 223.400 | 28.97 | 221.500 | 27.94 | 224.1 | 31.72 | 241.300 |
| 12 | 19.71 | 246.300 | 23.20 | 215.900 | 29.62 | 227.300 | 28.7 | 229.3 | 27.78 | 236.200 |
| 13 | 21.65 | 252.200 | 22.68 | 203.500 | 27.49 | 231.000 | 24.5 | 233.9 | 25.32 | 227.900 |
| 14 | 18.39 | 254.800 | 19.64 | 216.000 | 28.77 | 236.700 | 26.46 | 241 | 23.76 | 229.200 |
| 15 | 18.23 | 259.900 | 19.55 | 215.600 | 26.73 | 240.200 | 24.54 | 235 | 22.84 | 245.000 |
| 16 | 18.25 | 262.600 | 19.60 | 227.400 | 23.22 | 237.300 | 23.69 | 238.8 | 26.71 | 252.000 |
| 17 | 16.69 | 270.400 | 21.50 | 230.700 | 25.86 | 238.300 | 26.33 | 237.2 | 25.03 | 266.500 |
| 18 | 18.79 | 272.500 | 19.55 | 236.300 | 27.00 | 234.300 | 23.53 | 237.4 | 23.22 | 260.200 |
| 19 | 20.13 | 265.000 | 18.10 | 244.100 | 22.86 | 233.800 | 22.21 | 234 | 15.73 | 240.100 |
| 20 | 11.01 | 246.500 | 12.16 | 240.500 | 21.23 | 233.600 | 20.83 | 225.8 | 15.50 | 240.000 |
| 21 | 8.22 | 250.200 | 8.83 | 240.800 | 19.91 | 232.100 | 22.66 | 225.5 | 12.94 | 235.500 |
| 22 | 15.34 | 249.200 | 13.82 | 245.800 | 16.40 | 229.200 | 16.2 | 205.1 | 15.53 | 243.500 |
| 23 | 15.82 | 254.100 | 20.09 | 245.700 | 18.03 | 231.000 | 11.9 | 193.8 | 13.91 | 232.900 |

Table 3: Wind data from urban PAWS stations

| | **Kennewick** | | **Badger Canyon** | | **Benton City** | | **WSU Tri-Cities** | |
|---|---|---|---|---|---|---|---|---|
| Time | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) | Wind Speed (mph) | Wind Direction (degrees) |
| 0 | 9 | 226 | 13 | 222 | 9 | 305 | 7 | 171 |
| 1 | 6 | 204 | 9 | 205 | 4 | 270 | 7 | 175 |
| 2 | 7 | 210 | 10 | 215 | 4 | 275 | 2 | 150 |
| 3 | 9 | 228 | 10 | 226 | 9 | 263 | 4 | 182 |
| 4 | 11 | 227 | 11 | 219 | 8 | 253 | 6 | 187 |
| 5 | 12 | 218 | 12 | 208 | 7 | 247 | 12 | 175 |
| 6 | 11 | 217 | 12 | 214 | 11 | 266 | 7 | 168 |
| 7 | 13 | 230 | 14 | 225 | 18 | 256 | 13 | 192 |
| 8 | 17 | 226 | 14 | 221 | 16 | 255 | 17 | 194 |
| 9 | 15 | 225 | 14 | 221 | 16 | 258 | 20 | 189 |
| 10 | 17 | 226 | 18 | 221 | 19 | 247 | 21 | 184 |
| 11 | 17 | 226 | 19 | 220 | 18 | 246 | 23 | 179 |
| 12 | 16 | 223 | 17 | 222 | 13 | 283 | 19 | 194 |
| 13 | 17 | 227 | 19 | 225 | 11 | 289 | 19 | 227 |
| 14 | 17 | 226 | 15 | 220 | 11 | 289 | 20 | 228 |
| 15 | 12 | 234 | 18 | 235 | 11 | 304 | 21 | 230 |
| 16 | 12 | 241 | 18 | 236 | 10 | 304 | 18 | 229 |
| 17 | 12 | 246 | 18 | 234 | 13 | 290 | 16 | 233 |
| 18 | 13 | 241 | 18 | 231 | 15 | 292 | 15 | 224 |
| 19 | 11 | 237 | 16 | 228 | 10 | 270 | 13 | 227 |
| 20 | 11 | 232 | 17 | 228 | 10 | 290 | 7 | 197 |
| 21 | 13 | 226 | 14 | 224 | 12 | 303 | 14 | 203 |
| 22 | 14 | 223 | 14 | 215 | 10 | 280 | 12 | 193 |
| 23 | 13 | 227 | 15 | 214 | 8 | 312 | 9 | 185 |

Figure 4a: Photos from the day following the exceedance in the Horse Heaven Hills southwest of the Tri-Cities on 6-Mar-2003 show dust blowing from fallowed wheat fields.

Figure 4b: Large dust plume rises off fields heading towards Tri-Cities area 6-Mar-2003.

## Agricultural BACM Assessment

For agricultural sources, BACM is more commonly referred to as Best Management Practices (BMPs). A variety of management practices to control wind erosion and associated $PM_{10}$ emissions were one of the expected outcomes of the Columbia Plateau $PM_{10}$ Project. To qualify as a BMP, the practice must be proven to reduce wind erosion significantly below that which would occur with bare and tilled soil under similar weather conditions. Meteorological and climatological conditions strongly affect effective wind erosion or dust control on agricultural lands. Maintaining soil stability on agricultural fields is a problem in the Tri-Cities region principally during the most vulnerable times, such as crop planting and harvesting, or for other tillage operations that leave the soil vulnerable to wind erosion.

In the 2003 NEAP, Washington State found that BACM is implemented throughout the Columbia Plateau, which includes Benton County. Washington State evaluated BACM implementation for agricultural fields using Core 4 data. The Core 4 data shows 68% of total farmable acres of the Columbia Plateau are either part of a USDA conservation program, use one of several minimum till practices, or have 15 to 30% residue on the soil. Based on this evaluation, Washington State views these levels of wind erosion control as sufficient to fulfill BACM criterion of the Natural Events Policy.

In addition to currently implemented BACM there are on-going efforts to enhance wind erosion controls on the Horse Heaven Hills in Benton County. A $65,000 grant from EPA has made it possible for the Washington Department of Ecology to contract with the Benton Conservation District to carry out a project as an extension of the Columbia Plateau Wind Erosion/Air Quality Project (formerly CP3). The goals of the project are: 1) To provide immediate, temporary treatment to critical areas and 2) To promote other options for longer term or permanent wind erosion control measures. Specifically, a new six-bale Newhouse straw mulcher was purchased to apply straw on highly erodible areas. During parts of the last two cropping cycles, approximately 700 tons of surface residue was applied to protect against the occurrence of windblown dust from these areas. Conservation Reserve Program (CRP) acres have also increased over 100% since the latest USDA CRP signup, which brings the total CRP acres in the Horse Heaven Hills to 25,136 acres.

**Landscape Stability Conditions in the $PM_{10}$ Source Area**

The source area for $PM_{10}$ in the 5-Mar-2003 event was the Horse Heaven Hills dryland wheat growing area. Precipitation and its effects on wheat culture are the principal determinants of landscape stability. The effects of precipitation, both the amount and timing are two-fold and operate on different time scales. One is a cropping cycle time-scale (long-term, 12 to 24 months or more) and the other is an event time-scale (short-term, 24 to 72 hours).

Precipitation on an event time-scale can modify the susceptibility of the soil surface to particle detachment. Such precipitation effects are operative in the period of a few days prior to the wind event that causes the wind erosion. Recent precipitation within a few days prior to the wind event can suppress the amount of $PM_{10}$ emissions and lack of precipitation could have the opposite effect. Sufficient precipitation can suppress emissions to the point that no exceedance occurs.

Daily precipitation measurements from 4 Public Agricultural Weather System (PAWS) stations located at numerous geographically separated sites across the Horse Heaven Hills showed no precipitation for 15 to 16 consecutive days prior to the 5-Mar-2003 wind event. (Appendix A Table A5). Therefore, bare soil and low residue areas, which are highly vulnerable to wind erosion, received no stabilizing effects of precipitation for over two weeks before the wind event.

Precipitation on a cropping cycle time-scale affects residue production, which is more important for landscape stability than short-term, event time-scale precipitation. Cropping-cycle precipitation patterns are shown in Figure 5a. During the fallow year (Oct. 2001 to Aug. 2002) precipitation was below average (approx. 7.0 inches). Therefore, the amount of water stored in the soil profile during the fallow period was below average, which decreases the probability of establishing a winter wheat crop and decreases the potential for supporting its growth. The problem was made more severe with continued deficit of precipitation risk in the six months prior to 5-Mar-2003 (Figure 5b). Note that precipitation in the months immediately prior to March 2003 was at or above average. However, this was not sufficient to offset the accumulated overall moisture deficit from previous months. Many growers had already decided not to plant wheat in the fall and instead waited until spring to seed. The moisture received in December 2002 and January and February 2003 did provide a good situation for establishing spring wheat and did justify that management decision. The combination of low soil moisture and below normal precipitation during the fall seeding period increased the risk of planting and not establishing vigorous seedlings.

Figure 5a:

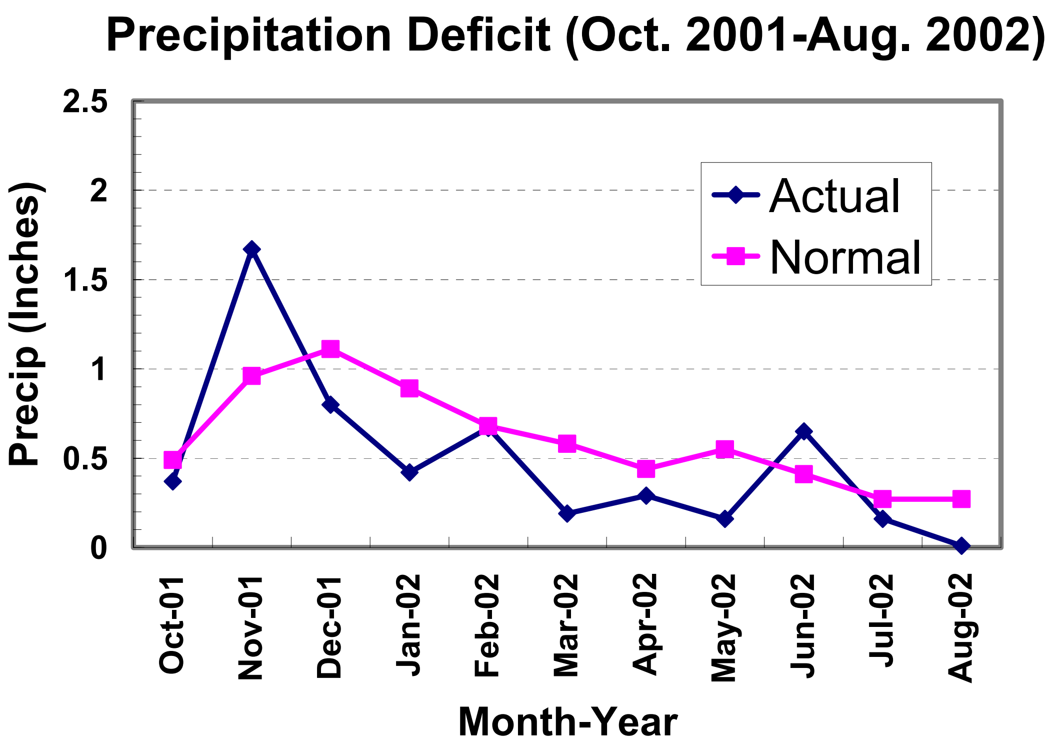
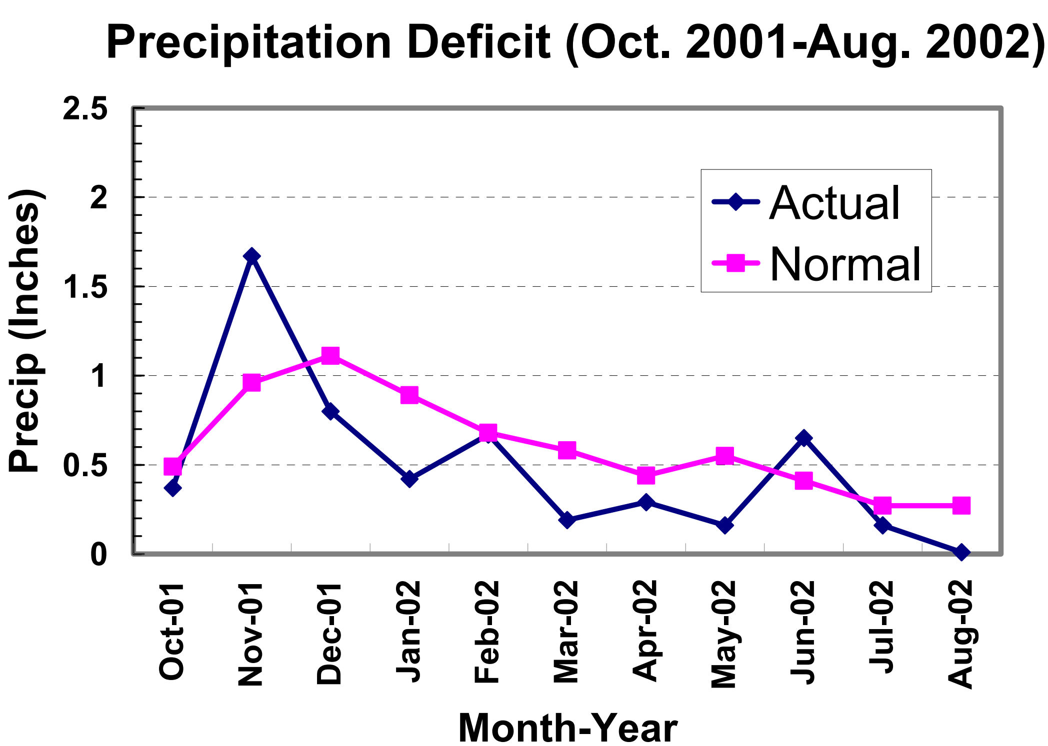



Figure 5b:



Because of this risk, grower management decisions range from seeding with hope for near-future rain, waiting to plant until after fall precipitation occurs, or waiting until spring to plant a spring variety of wheat. Some growers may have attempted seeding operations one or more times in the fall as they gamble on rains coming in time to support seedling development. Each re-seeding further disturbs the soil, buries surface residue, and degrades the soil physical condition. All these activities result in a lower landscape stability and increases vulnerability to wind erosion.

The effect of the 2001 to 2003 cropping-cycle precipitation deficit was that a significant acreage of spring wheat seeding operations occurred just before the 5-Mar-2003 windblown dust event. Most likely, the largest sources of dust on 5-Mar-2003 were from dryland fields being prepared for seeding of spring wheat and fields that had recently been planted to spring wheat. These spring wheat fields are particularly vulnerable to wind erosion during preparation for planting and following planting because of the disturbed soil condition. Any tillage that prepares the fields for planting and the planting operations themselves reduce surface residue. This reduction combined with a reduced supply of residue from low wheat yields in the previous crop cycle further increases susceptibility to wind erosion. In addition, there were likely many vulnerable fields that were seeded in the fall, which after the December to February precipitation began to germinate or resume growth of small seedlings that were not sufficiently established to prevent wind erosion.

Dryland fields continue in this vulnerable condition after planting until a sufficient cover of new crop growth can be established. Depending on weather conditions and soil temperature during this period, seedling and stand establishment emergence can take several weeks. Even winter wheat fields planted the previous fall may not have sufficient cover to hold against erosive wind in the spring. Once the crop cover is established, the soil surface is increasingly protected as the crop grows and wind erosion potential decreases and approaches zero.

Another possible soil disturbing activity is spring potato planting that was occurring before the 5-Mar-2003 event and that leaves minimal crop residue and loosens the soil surface. There was no practical way to determine the amounts of spring wheat or irrigated potato planting activity.

In summary, the combined effects of deficits of cropping-cycle precipitation and lack of rainfall for over 14 consecutive days (greater than 72 hours) prior to 5-Mar-2003 (Table 3) resulted in a vulnerable unstable landscape that was susceptible to wind erosion when the 5 Mar 2003 wind event occurred.

## SUMMARY AND CONCLUSIONS

From the evidence presented, the following conclusions can be drawn:

1. The Tri-Cities area and outlying agricultural areas were subjected to high wind speeds on 5-Mar-2003.

2. Agricultural fields, which were highly susceptible to wind erosion during the 5-Mar-2003 wind events, included dryland wheat fields and irrigated potato fields being prepared for planting and some fallowed fields with insufficient crop residue were blowing most severely.

3. The combination of the wind event, which had the necessary wind speed, duration, and direction to generate and transport $PM_{10}$, and the vulnerable landscape, caused the 5-Mar-2003 exceedance. Although the agricultural fields have BACM applied there were certain conditions present-spring planting not emerged, reduced residue due to drought, recent potato and wheat planting – that allow these winds to overcome BACM more easily than usual. In addition, any unprotected area of soil surface at construction sites or elsewhere in the landscape would have potential to contribute to the exceedance.

4. The lack of direct observational evidence of other significant emission sources (other than windblown fugitive dust from agricultural fields) and the acknowledgment that the Columbia Plateau is, in general, highly susceptible to high wind events, show that windblown dust is the most probable source of the $PM_{10}$.

5. Based upon these conclusions, the BCAA considers the $PM_{10}$ concentration recorded on 5-Mar-2003 to have been caused by a high wind natural event and requests that the data for this date be flagged as such in the AIRS database.

## ABBREVIATIONS AND ACRONYMS

BACM................Best Available Control Measures

BMP ..................Best Management Practices

SLAMS..............State and Local Air Monitoring Station

EPA...................U.S. Environmental Protection Agency

BCAA ................Benton Clean Air Authority

BFWWCAPCA ..Benton Franklin Walla Walla Counties Air Pollution Control Authority, renamed BCAA in 1995

MET...................Meteorological

NAAQS.............National Ambient Air Quality Standard

$PM_{10}$ ..................Particulate Matter, 10 microns in diameter

Ecology .............Washington State Department of Ecology

PST ...................Pacific Standard Time

NEP...................Natural Events Policy

NEAP ................Natural Event Action Plan

MOA..................Memorandum of Agreement

RACM................Reasonably Available Control Measures

FDP...................BCAA Fugitive Dust Policy

HMN..................Hanford Meteorological Network

PAWS................Public Agricultural Weather System operated by Washington State University

CFR...................U.S. Code of Federal Regulations

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## APPENDICIES

# Appendix A

## Table A1: Daily $PM_{10}$ Concentration ($ug/m^3$) for 2002

| | | | | | |
|---|---|---|---|---|---|
| STATION: | KENNEWICK, VSC | POLLUTANT: | PM10 | YEAR: | 2002 |
| SITE #: | 0340003J | POLLUTANT CODE: | 81102 | DECIMAL POS.: | 0 |
| PROJECT | 1 | METHOD: | 63 | UNITS: | µg/m³ |

| CA | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN | MAX | NO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 6 | 20 | 18 | | 17 | 12 | 42 | 21 | 15 | 33 | 13 | 19.0 | 42.0 | 11 |
| 2 | 8 | 15 | 18 | 20 | 149 | 14 | 18 | 25 | 28 | 25 | 36 | 11 | 30.6 | 149.0 | 12 |
| 3 | 14 | 9 | 16 | 24 | 18 | 20 | 35 | 24 | | 12 | 38 | 13 | 20.3 | 38.0 | 11 |
| 4 | 11 | 13 | 48 | 29 | 21 | 19 | 12 | | 23 | 13 | | 16 | 20.5 | 48.0 | 10 |
| 5 | 15 | 19 | 51 | 34 | 68 | 67 | 15 | 16 | 27 | 13 | 51 | 21 | 33.1 | 68.0 | 12 |
| 6 | 13 | 21 | 9 | 30 | 11 | 12 | 20 | 25 | 24 | 9 | 56 | 6 | 19.7 | 56.0 | 12 |
| 7 | | 7 | 12 | 11 | 12 | 16 | 41 | 19 | 38 | 16 | 63 | 11 | 22.4 | 63.0 | 11 |
| 8 | 4 | 4 | 9 | 23 | 17 | 9 | 17 | 21 | 14 | 21 | | 15 | 14.0 | 23.0 | 11 |
| 9 | 15 | 9 | 13 | 28 | 15 | 6 | 20 | 23 | 27 | 17 | 7 | 18 | 16.5 | 28.0 | 12 |
| 10 | 19 | 11 | 12 | 17 | 17 | 10 | 26 | 16 | 34 | 15 | 4 | 12 | 16.1 | 34.0 | 12 |
| 11 | 21 | 7 | | 8 | 19 | 11 | 39 | 29 | 37 | 16 | 9 | 11 | 18.8 | 39.0 | 11 |
| 12 | 19 | 15 | 17 | 26 | 24 | 20 | 35 | 28 | 45 | 26 | | 15 | 24.5 | 45.0 | 11 |
| 13 | 11 | 18 | 9 | 56 | 68 | 28 | 65 | 26 | 37 | | 8 | 10 | 30.5 | 68.0 | 11 |
| 14 | 12 | 26 | 7 | 22 | 13 | 30 | 37 | 29 | | | 14 | | 21.1 | 37.0 | 9 |
| 15 | 17 | 16 | 10 | | 18 | 27 | 25 | 34 | 62 | 39 | 24 | 5 | 25.2 | 62.0 | 11 |
| 16 | 12 | 16 | 5 | 23 | 28 | 44 | 34 | 186 | 40 | 42 | 43 | 24 | 41.4 | 186.0 | 12 |
| 17 | 18 | 24 | 12 | 8 | 25 | 14 | 31 | 89 | 14 | 49 | 9 | 12 | 25.4 | 89.0 | 12 |
| 18 | 14 | 24 | 12 | 12 | 14 | 15 | 29 | 19 | 16 | 58 | 9 | 10 | 19.3 | 58.0 | 12 |
| 19 | 2 | | 72 | 13 | 17 | 11 | 26 | 34 | 29 | 36 | 81 | 14 | 30.5 | 81.0 | 11 |
| 20 | 12 | 14 | 20 | 13 | 12 | 23 | 32 | 20 | 19 | 15 | 14 | 10 | 17.0 | 32.0 | 12 |
| 21 | 2 | 16 | 22 | 57 | 11 | 25 | 31 | 14 | 21 | 26 | 23 | 4 | 21.0 | 57.0 | 12 |
| 22 | 7 | 13 | | 57 | 15 | 29 | | 18 | | 36 | 22 | 11 | 23.1 | 57.0 | 9 |
| 23 | 9 | 5 | 26 | 16 | 12 | 24 | 78 | 21 | | 32 | 12 | 18 | 23.0 | 78.0 | 11 |
| 24 | 10 | 10 | 18 | 19 | 18 | | 56 | 27 | 50 | 41 | 12 | 16 | 25.2 | 56.0 | 11 |
| 25 | 5 | | 10 | 31 | 21 | 28 | 50 | 39 | 29 | 45 | 21 | 19 | 27.1 | 50.0 | 11 |
| 26 | 2 | 13 | 23 | 29 | 12 | 34 | 49 | 15 | 49 | 40 | 28 | 8 | 25.2 | 49.0 | 12 |
| 27 | 6 | 27 | 33 | 5 | 14 | 46 | 30 | 29 | 24 | 51 | 28 | 7 | 25.0 | 51.0 | 12 |
| 28 | 12 | 14 | 37 | | 6 | 16 | 39 | 31 | 19 | 28 | 23 | 2 | 20.6 | 39.0 | 11 |
| 29 | 12 | | 12 | | 11 | 17 | 22 | 38 | | 52 | 25 | 2 | 21.2 | 52.0 | 9 |
| 30 | 15 | | 13 | 22 | 13 | 10 | 52 | 75 | 11 | 12 | 14 | 5 | 22.0 | 75.0 | 11 |
| 31 | 5 | | 27 | | 19 | | 35 | 26 | | | | 7 | 19.8 | 35.0 | 6 |
| AVG | 11.1 | 14.3 | 20.4 | 24.1 | 23.9 | 22.1 | 33.7 | 34.6 | 29.5 | 28.6 | 26.2 | 11.5 | 23.3 | | |
| MAX | 21.0 | 27.0 | 72.0 | 57.0 | 149.0 | 67.0 | 78.0 | 186.0 | 62.0 | 58.0 | 81.0 | 24.0 | | 186.0 | |
| DAYS | 30.0 | 26.0 | 29.0 | 27.0 | 30.0 | 29.0 | 30.0 | 30.0 | 25.0 | 28.0 | 27.0 | 30.0 | | | 341 |

## Table A2: Daily $PM_{10}$ Concentration (ug/m$^3$) for 2003

| | | | | | |
|---|---|---|---|---|---|
| STATION: | KENNEWICK, VSC | POLLUTANT: | PM10 | YEAR: | 2003 |
| SITE #: | 0340003J | POLLUTANT CODE: | 81102 | DECIMAL POS.: | 0 |
| PROJECT | 1 | METHOD: | 63 | UNITS: | µg/m³ |

| CA | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | MEAN | MAX | NO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 5 | 22 | 10 | 11 | 16 | 23 | 32 | | | | | 15.9 | 32.0 | 8 |
| 2 | 12 | 5 | 17 | 6 | 21 | 25 | 18 | 26 | | | | | 16.3 | 26.0 | 8 |
| 3 | 7 | | | 32 | 28 | 24 | 24 | 21 | | | | | 22.7 | 32.0 | 6 |
| 4 | 5 | 13 | 11 | 11 | 33 | 25 | 21 | 47 | | | | | 20.8 | 47.0 | 8 |
| 5 | 6 | 21 | 186 | 10 | 14 | | 20 | 45 | | | | | 43.1 | 186.0 | 7 |
| 6 | 13 | 26 | 126 | 4 | 13 | 34 | | 19 | | | | | 33.6 | 126.0 | 7 |
| 7 | 11 | 27 | 21 | 10 | 17 | 27 | | 18 | | | | | 18.7 | 27.0 | 7 |
| 8 | 12 | 20 | 7 | 16 | 18 | 36 | 36 | 16 | | | | | 20.1 | 36.0 | 8 |
| 9 | 11 | 22 | 33 | 13 | 20 | 27 | 27 | 80 | | | | | 29.1 | 80.0 | 8 |
| 10 | | 22 | 17 | 17 | 17 | 33 | | 15 | | | | | 20.2 | 33.0 | 6 |
| 11 | 14 | 20 | 34 | 7 | 15 | 19 | 42 | 14 | | | | | 20.6 | 42.0 | 8 |
| 12 | 14 | 18 | | 11 | 13 | 28 | 69 | 16 | | | | | 24.1 | 69.0 | 7 |
| 13 | 14 | 16 | 60 | 9 | 16 | 37 | 25 | 30 | | | | | 25.9 | 60.0 | 8 |
| 14 | 13 | 22 | 19 | | 34 | 15 | 22 | 34 | | | | | 22.7 | 34.0 | 7 |
| 15 | 9 | 17 | | 9 | 39 | 17 | 30 | 62 | | | | | 26.1 | 62.0 | 7 |
| 16 | 12 | 4 | | | 8 | 28 | 25 | 41 | | | | | 19.7 | 41.0 | 6 |
| 17 | | 4 | | 11 | 9 | 34 | 22 | 17 | | | | | 16.2 | 34.0 | 6 |
| 18 | 10 | | 12 | 7 | 9 | 65 | 29 | | | | | | 22.0 | 65.0 | 6 |
| 19 | 12 | 15 | 10 | 15 | 14 | 50 | 33 | 50 | | | | | 24.9 | 50.0 | 8 |
| 20 | 6 | 14 | 36 | 14 | 18 | 17 | 23 | 41 | | | | | 21.1 | 41.0 | 8 |
| 21 | | 9 | 6 | 13 | 16 | 20 | 25 | 54 | | | | | 20.4 | 54.0 | 7 |
| 22 | 5 | 5 | 9 | 17 | 27 | 9 | 43 | 40 | | | | | 19.4 | 43.0 | 8 |
| 23 | 12 | 10 | 11 | 16 | 72 | 16 | 36 | 21 | | | | | 24.3 | 72.0 | 8 |
| 24 | 19 | 14 | 11 | 15 | 24 | 19 | 39 | 16 | | | | | 19.6 | 39.0 | 8 |
| 25 | 21 | 27 | | 4 | 13 | 22 | 34 | | | | | | 20.2 | 34.0 | 6 |
| 26 | 4 | 25 | 19 | 2 | 9 | 30 | 35 | 31 | | | | | 19.4 | 35.0 | 8 |
| 27 | 6 | 25 | 16 | 3 | 10 | 22 | 29 | 17 | | | | | 16.0 | 29.0 | 8 |
| 28 | 9 | 19 | 13 | | 22 | 22 | 37 | 24 | | | | | 20.9 | 37.0 | 7 |
| 29 | 10 | | 14 | 5 | 21 | 32 | 40 | 55 | | | | | 25.3 | 55.0 | 7 |
| 30 | 11 | | 20 | 5 | 28 | 43 | 44 | 45 | | | | | 28.0 | 45.0 | 7 |
| 31 | 6 | | 29 | | 17 | | 35 | 40 | | | | | 25.4 | 40.0 | 5 |
| AVG | 10.4 | 16.3 | 30.4 | 10.8 | 20.2 | 27.3 | 31.6 | 33.3 | -- | -- | -- | -- | 22.6 | | |
| MAX | 21.0 | 27.0 | 186.0 | 32.0 | 72.0 | 65.0 | 69.0 | 80.0 | -- | -- | -- | -- | | 186.0 | |
| DAYS | 28.0 | 26.0 | 25.0 | 27.0 | 31.0 | 29.0 | 28.0 | 29.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | 223 |

## Table A3: Wind Data (2000 PST 4-Mar-2003 through 1200 PST 6-Mar-2003)

| | Gramling | | Horrigan | | Station 2 | | Station 4 | |
|---|---|---|---|---|---|---|---|---|
| Time (PST) | Wind Speed | Wind Direction | Wind Speed | Wind Direction | Wind Speed | Wind Direction | Wind Speed | Wind Direction |
| 2000 | 15.37 | 219.600 | 15.37 | 194.200 | 6.17 | 215.900 | 5.97 | 190.000 |
| 2100 | 13.70 | 213.600 | 13.70 | 300.200 | 7.84 | 219.800 | 4.27 | 197.900 |
| 2200 | 10.19 | 194.700 | 10.19 | 297.400 | 7.23 | 233.200 | 1.57 | 211.200 |
| 2300 | 11.15 | 221.100 | 11.15 | 201.900 | 9.19 | 231.500 | 3.37 | 239.600 |
| 0000 | 20.40 | 229.600 | 20.40 | 249.600 | 17.65 | 226.700 | 13.55 | 223.100 |
| 0100 | 10.77 | 193.300 | 10.77 | 193.600 | 5.90 | 226.100 | 3.88 | 205.400 |
| 0200 | 13.64 | 203.200 | 13.64 | 212.500 | 8.48 | 228.000 | 4.65 | 198.100 |
| 0300 | 18.41 | 218.600 | 18.41 | 226.600 | 13.13 | 224.300 | 6.22 | 211.200 |
| 0400 | 18.92 | 224.200 | 18.92 | 253.800 | 15.86 | 225.300 | 7.20 | 205.600 |
| 0500 | 15.82 | 211.200 | 15.82 | 193.900 | 17.69 | 219.100 | 11.42 | 216.700 |
| 0600 | 19.13 | 214.500 | 19.13 | 233.200 | 17.07 | 227.400 | 14.08 | 222.100 |
| 0700 | 23.51 | 219.000 | 23.51 | 223.000 | 16.51 | 217.300 | 12.47 | 212.400 |
| 0800 | 27.11 | 222.300 | 27.11 | 225.700 | 14.47 | 215.000 | 14.41 | 211.800 |
| 0900 | 25.61 | 226.100 | 25.61 | 219.400 | 22.57 | 221.600 | 21.70 | 218.700 |
| 1000 | 29.68 | 230.100 | 29.68 | 213.700 | 28.01 | 221.600 | 26.98 | 215.900 |
| 1100 | 31.21 | 226.200 | 31.21 | 223.400 | 30.51 | 221.800 | 30.62 | 214.500 |
| 1200 | 30.83 | 228.000 | 30.83 | 215.900 | 32.35 | 222.600 | 32.30 | 218.200 |
| 1300 | 30.83 | 236.500 | 30.83 | 203.500 | 27.63 | 219.500 | 29.10 | 222.900 |
| 1400 | 27.02 | 234.700 | 27.02 | 216.000 | 25.23 | 211.600 | 27.67 | 222.200 |
| 1500 | 26.53 | 232.500 | 26.53 | 215.600 | 25.17 | 218.200 | 28.83 | 228.000 |
| 1600 | 26.26 | 238.000 | 26.26 | 227.400 | 29.06 | 228.200 | 25.86 | 226.300 |
| 1700 | 28.61 | 241.100 | 28.61 | 230.700 | 28.61 | 227.400 | 27.76 | 228.500 |
| 1800 | 27.27 | 248.300 | 27.27 | 236.300 | 28.72 | 234.600 | 28.01 | 230.700 |
| 1900 | 24.83 | 237.100 | 24.83 | 244.100 | 20.67 | 235.100 | 24.85 | 227.200 |
| 2000 | 23.02 | 231.200 | 23.02 | 240.500 | 21.94 | 238.500 | 24.50 | 234.900 |
| 2100 | 21.99 | 227.200 | 21.99 | 240.800 | 15.90 | 234.600 | 20.09 | 223.600 |
| 2200 | 23.56 | 226.400 | 23.56 | 245.800 | 14.15 | 232.000 | 18.88 | 220.900 |
| 2300 | 24.25 | 227.500 | 24.25 | 245.700 | 14.91 | 230.500 | 15.53 | 226.600 |
| 0000 | 14.89 | 197.700 | 14.89 | 216.000 | 10.95 | 226.200 | 12.01 | 220.900 |
| 0100 | 14.86 | 221.900 | 14.86 | 267.500 | 15.12 | 230.000 | 12.99 | 223.500 |
| 0200 | 10.94 | 220.700 | 10.94 | 277.200 | 11.57 | 221.700 | 10.06 | 223.700 |
| 0300 | 9.06 | 200.700 | 9.06 | 289.700 | 10.64 | 217.300 | 7.87 | 226.000 |
| 0400 | 11.82 | 195.100 | 11.82 | 280.300 | 10.65 | 226.300 | 5.02 | 207.300 |
| 0500 | 11.56 | 226.700 | 11.56 | 277.100 | 12.22 | 233.500 | 6.02 | 232.100 |
| 0600 | 7.82 | 236.000 | 7.82 | 280.200 | 8.17 | 228.500 | 4.91 | 227.000 |
| 0700 | 10.08 | 220.100 | 10.08 | 269.900 | 6.66 | 218.500 | 4.58 | 196.200 |
| 0800 | 10.43 | 210.100 | 10.43 | 263.300 | 13.37 | 227.800 | 10.80 | 207.100 |
| 0900 | 12.14 | 215.200 | 12.14 | 259.000 | 16.42 | 221.000 | 14.97 | 208.100 |
| 1000 | 16.67 | 228.400 | 16.67 | 264.000 | 19.24 | 218.000 | 18.32 | 212.400 |
| 1100 | 18.57 | 225.600 | 18.57 | 262.500 | 22.10 | 220.200 | 22.44 | 212.300 |
| 1200 | 24.79 | 240.700 | 24.79 | 256.600 | 25.81 | 230.900 | 27.40 | 230.600 |

### Table A4: Data Sets Used to Produce Precipitation Graphs Figures 6a and 6bw

| | Actual (Inches) | Normal (Inches) | Difference (Inches) |
|---|---|---|---|
| October-01 | 0.37 | 0.49 | -0.12 |
| November-01 | 1.67 | 0.96 | 0.69 |
| December-01 | 0.8 | 1.11 | -0.31 |
| January-02 | 0.42 | 0.89 | -0.47 |
| February-02 | 0.67 | 0.68 | -0.01 |
| March-02 | 0.19 | 0.58 | -0.39 |
| April-02 | 0.29 | 0.44 | -0.15 |
| May-02 | 0.16 | 0.55 | -0.39 |
| June-02 | 0.65 | 0.41 | 0.24 |
| July-02 | 0.16 | 0.27 | -0.11 |
| August-02 | 0.01 | 0.27 | -0.26 |
| September-02 | 0 | 0.33 | -0.33 |
| October-02 | 0.12 | 0.49 | -0.37 |
| November-02 | 0.38 | 0.98 | -0.6 |
| December-02 | 2.36 | 1.11 | 1.25 |
| January-03 | 1.87 | 0.87 | 1 |
| February-03 | 0.82 | 0.68 | 0.14 |
| | | | |
| Totals | 10.94 | 11.11 | - 0.17 |

## Table A5: Kennewick Area Precipitation 1-Feb-2003 through 5-Mar-2003

| Date | Kennewick Precipitation (In.) | Benton City Precipitation (In.) | Carlson Precipitation (In.) | Horrigan Precipitation (In.) |
|---|---|---|---|---|
| 2/01/2003 | 0 | 0 | 0 | 0 |
| 2/02/2003 | 0 | 0 | 0 | 0 |
| 2/03/2003 | 0 | 0 | 0 | 0 |
| 2/04/2003 | 0 | 0 | 0 | 0 |
| 2/05/2003 | 0 | 0 | 0 | 0 |
| 2/06/2003 | 0 | 0 | 0 | 0 |
| 2/07/2003 | 0 | 0 | 0 | 0 |
| 2/08/2003 | 0 | 0 | 0 | 0 |
| 2/09/2003 | 0 | 0 | 0 | 0 |
| 2/10/2003 | 0 | 0 | 0 | 0 |
| 2/11/2003 | 0 | 0 | 0 | 0 |
| 2/12/2003 | 0 | 0 | 0 | 0 |
| 2/13/2003 | .19 | .14 | 0.24 | .21 |
| 2/14/2003 | 0 | 0 | 0.02 | 0 |
| 2/15/2003 | .11 | .15 | 0.11 | .11 |
| 2/16/2003 | .24 | .18 | 0.27 | .26 |
| 2/17/2003 | .12 | .17 | 0.44 | .25 |
| 2/18/2003 | .03 | 0 | 0 | .02 |
| 2/19/2003 | 0 | 0 | 0 | 0 |
| 2/20/2003 | 0 | 0 | 0 | 0 |
| 2/21/2003 | 0 | 0 | 0 | 0 |
| 2/23/2003 | 0 | 0 | 0 | 0 |
| 2/24/2003 | 0 | 0 | 0 | 0 |
| 2/25/2003 | 0 | 0 | 0 | 0 |
| 2/26/2004 | 0 | 0 | 0 | 0 |
| 2/27/2003 | 0 | 0 | 0 | 0 |
| 2/28/2003 | 0 | 0 | 0 | 0 |
| 3/01/2003 | 0 | 0 | 0 | 0 |
| 3/02/2003 | 0 | 0 | 0 | 0 |
| 3/03/2003 | 0 | 0 | 0 | 0 |
| 3/04/2003 | 0 | 0 | 0 | 0 |
| 3/05/2003 | 0 | 0 | 0 | 0 |

**Reply to, "Comments On PM10 Natural Event – Kennewick, WA – March 5, 2003 By William Puckett"**.

**Comment #1)**
The NEAP mentions two scenarios for windblown dust events:

A. A sustained wind of at least 13 mph for at least two consecutive hours and conditions of higher susceptibility to wind erosion exist.
B. A sustained wind of at least 18 mph for at least two consecutive hours.

Clearly scenario B requires much less documentation and analysis than scenario A. DOE never clearly stated what scenario that they chose for documentation of the event. The documentation suggests that they are attempting to make a case for both scenarios. The wind data in Appendix B clearly shows that the event meets the scenario B definition. (The wind speed units are missing from Appendix B. Units must be included so that we can evaluate the status of the event compared to the NEAP.)

**Reply #1)**
Inserted, Page 6, $1^{st}$ paragraph, ".Analysis of the high wind event uses the "18 + 2" classification and summarizes the circumstances and characteristics of the event."

**Comment #2)**
Page 6. An error is made in referring to average January and February, 2003 PM10 concentrations respectively in Table A-2. DOE states that the average January PM10 concentration was 11.1 ug/m3 and February was 14.3 ug/m3. Table A-2 shows the average January concentration to be 10.4 ug/m3 and February to be 16.3 ug/m3. DOE transposed Table A-1 with Table A-2 in that they read the 2002 concentrations rather than 2003. This is not a big issue, but it is relevant if DOE is using this argument to document the event.

**Reply #2)**
Corrected, Page 6, $2^{nd}$ paragraph, "The average $PM_{10}$ concentration in the months prior to the 5-Mar-2003 exceedance was 10.4 ug/$m^3$ in January 2003 and 16.3 ug/$m^3$ in February 2003.

**Comment #3)**
Page 9 – Synoptic weather maps. What are times on Figures 2b and 2c? I am assuming that the times are 12z (4 am PST) because that is the time for the first map (Figure 2a).

**Reply #3)**
Inserted, Page 9, "0400 PST" on synoptic weather map description

**Comment #4)**
Page 10 – How were wind data composited in Figure 3b and 3c? Were they averaged? If so, were they vector or scalar averaged? It is much better to display wind data for individual sites than to try to average. (The wind data tables in Appendix B are much more informative.)

**Reply #4)**
Figures 3b and 3c were deleted from the document, Appendix B, rural and urban wind data tables were inserted on page 11 & 12.

**Comment #5)**
Page 13 - The wind rose format is somewhat confusing. The persistent winds from the southwest are illustrated, but that is about all of the information that is extractable. What are the location of the Alderdale, Wheelhouse, and Paterson weather stations on map (Figure 3a – page 10)?

**Reply #5)**
Wind roses were deleted from the document. Wind speeds and wind directions are obtained from tables 2 & 3 on pages 11 & 12. Map 3a shows the location of the Alderdale, Wheelhouse and Paterson with respect to the Kennewick SLAMS.

**Comment #6)**
Page 20 in the top paragraph the last sentence reads: "The amount of land area where planting of winter wheat was intended, but failed, the amount of surface residue coverage, and the amount of farming operation on the land determines the overall landscape stability." I cannot determine what the writer is trying to say in this sentence. Please rewrite more clearly

**Reply #6)**
Page 18, 1st paragraph, last sentence was deleted.

**Comment #7)**
Page 20 – Statement is made that no rain fell for 14 consecutive days prior to the March 5, 2003 event. No precipitation records are provided to substantiate this claim. Please provide daily precipitation records for all stations in the area for February and the first five days in March 2003.

**Reply #7)**
Table A5 was inserted into appendix A which shows precipitation records for PAWS stations in the area.