EPA assessment / May 2010: Inhalation of Fugitive Dust: A Screening Assessment of the Risks Posed by Coal Combustion wastes Landfills.

1.0 Introduction

Inhalation of Fugitive Dust is intended to be a companion document to the U.S. Environmental Protection Agency's (EPA) 2009 *Human and Ecological Risk Assessment of Coal Combustion Wastes* (U.S. EPA, 2009). In 2007, EPA released its draft risk assessment (U.S. EPA, 2007). This document was released to a panel of five peer reviewers, and to the public via a notice of data availability (NODA) in the Federal Register.[1] In both the peer review and NODA, EPA received comments regarding fugitive dust. These comments pointed out that fugitive dust emissions during the operation of a coal combustion waste (CCW) management unit (WMU) were not addressed in the draft risk assessment (RA). However, since there was anecdotal evidence that fugitive dust was often emitted from WMUs, EPA decided to examine the potential for uncontrolled emissions from dry handling to lead to significant human health risks.

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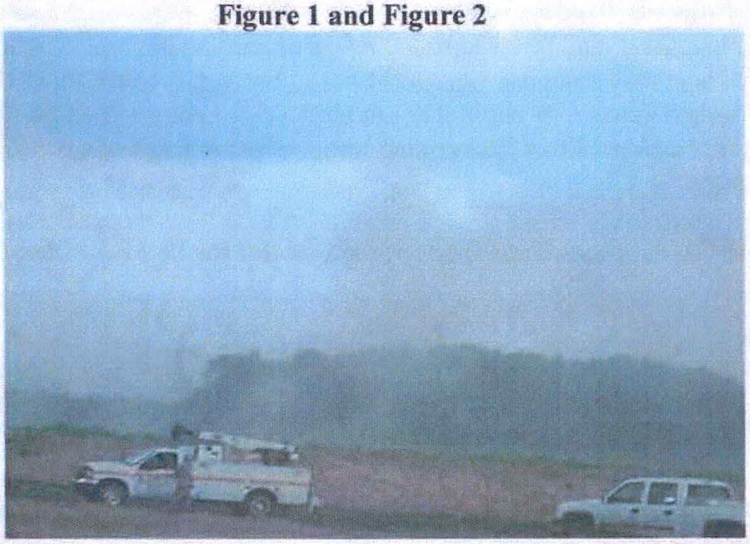
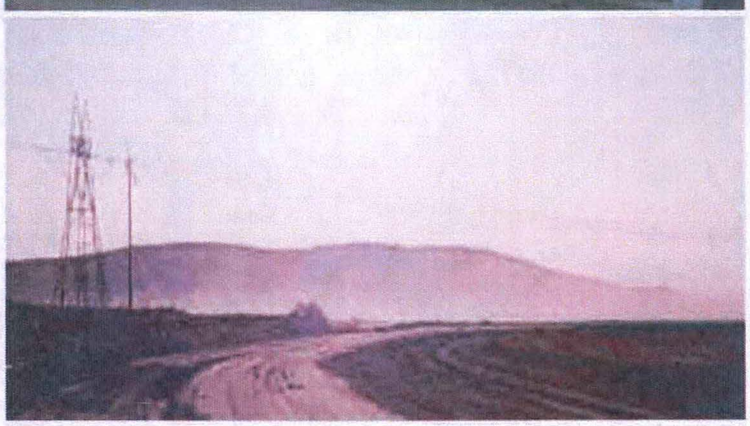
Figure 1 and Figure 2





Fugitive dust associated with CCW landfilling operations.
***Top**: Gambrills, MD; **Bottom**: Four Corners, NM.*[2]

[1] Docket ID: EPA-HQ-RCRA-2006-0796. Document ID: EPA-HQ-RCRA-2006-0796-0042.
[2] Photos courtesy of Lisa Evans, Earthjustice

Exhibit No. 337
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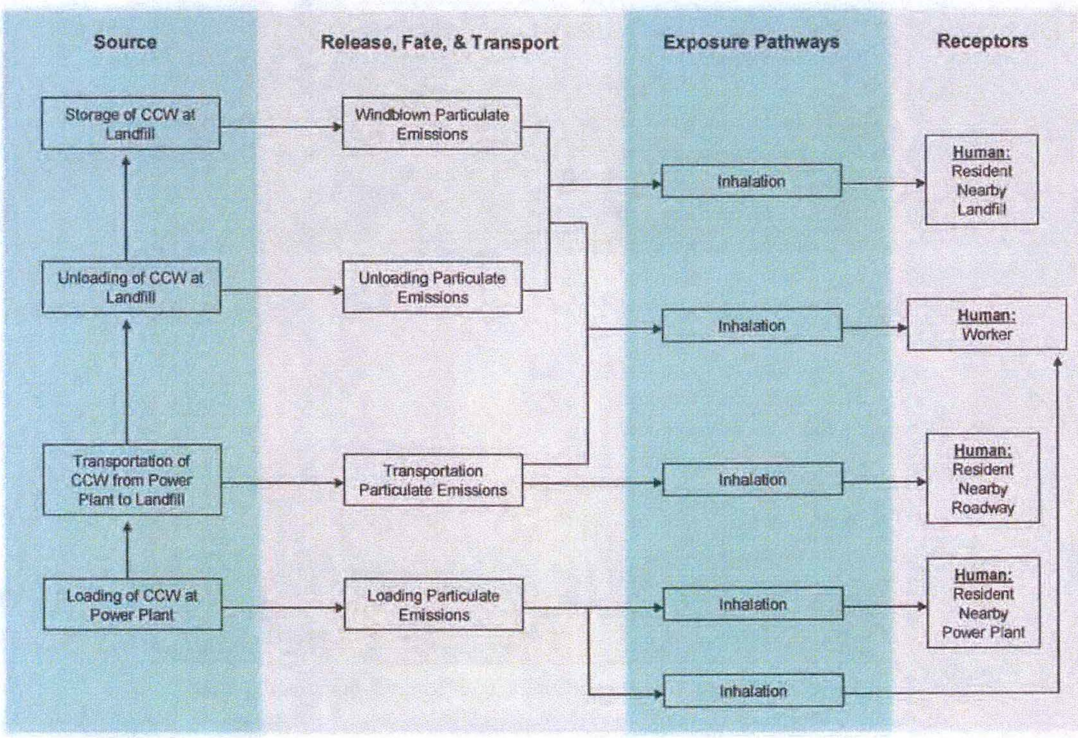
2.0 Inhalation of CCW Emitted from Landfilling Operations

When dry-handled, CCW will be emitted into the air by loading, transport, unloading, and wind erosion. Once in the air, it will likely migrate off-site as fugitive dust. As a result, workers and nearby residents could be exposed to significant amounts of coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$). The purpose of this assessment is therefore to assess whether the national ambient air quality standards (NAAQS) for particulate matter could be violated through CCW landfilling operations[3] without fugitive dust controls. This will be accomplished through a conservative screening analysis. Figure 3 below shows the conceptual model for the type of landfilling operation relevant here. If the inhalation pathway cannot be screened out, then it is possible for fugitive dust to pose a threat to human health, and regulation addressing fugitive dust should be considered. Conversely, if the inhalation pathway can be screened out, then it is highly unlikely that the inhalation of particulates from CCW landfills poses a significant risk to human health. However, there are two uncertainties inherent in this bright line screen evaluated in this report. First, there may be background levels of particulates which, when added to the levels calculated here may still pose significant risks. Second, it would still be possible for constituents adsorbed onto CCW particulates to pose a risk to human health. This screening evaluation does not address either background levels of particulates or a constituent-based exposure pathway.

Figure 3 – Fugitive Dust Conceptual Model for Dry Handling of CCW



[3] This does not include activities such as minefilling, reclamation of sand and gravel pits, or beneficial use.

2.1 Initial Scenario

Three groups of residents are likely to be exposed to fugitive dust as a result of the dry handling of CCW.[4] Residents living near a coal power plant could be exposed to emissions resulting from loading of the CCW. Residents near roads could be exposed to emissions during transportation. Finally, residents living near CCW landfills could be exposed from both the unloading and windblown emissions.

Residents living near a CCW landfill will often be exposed to more fugitive dust, and for longer periods of time, than those living near the roads or power plants themselves. This is the case because these residents would be exposed to emissions from both unloading of CCW and windblown emissions of CCW. Thus, only the residents living near CCW landfills will be considered further as they represent a highly exposed population. In addition, as a landfill gets closer to capacity, the less relative influence unloading emissions would have on total emissions. In the preliminary scenario considered, the entire landfill is left exposed to wind until the end of its useful life. Thus, windblown emissions could be considered representative of total emissions as they would dominate.

To estimate the concentration of fugitive dust in the air near a CCW landfill, the SCREEN3 model was used.[5] SCREEN3 (a screening version of ISC3) is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources. It was developed to provide an easy-to-use method of obtaining pollutant concentration estimates based on *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources* (U.S. EPA, 1995c). A technical description of the SCREEN3 model is provided in Appendix E. The SCREEN3 outputs will then be compared to the relevant NAAQS as presented in Table 1 below.

Table 1 – NAAQS for Particulate Matter

Pollutant	Standard	Averaging Time
PM_{10}	150 $\mu g\ m^{-3}$	24-hour
$PM_{2.5}$	15.0 $\mu g\ m^{-3}$	Annual
$PM_{2.5}$	35 $\mu g\ m^{-3}$	24-hour

See 40 C.F.R. 50[6]

2.2 Emission Factors

In order to model the concentration of the particulate matter in the air, it is necessary to estimate the emission rate for the CCW managed in landfills. A point estimate for the windblown emission factor was calculated below using the equation for "Continuous Fugitive/Windblown Dust Emissions" (U.S. EPA, 1992):

[4] Workers who handle CCW would also be exposed to fugitive dust, but they are protected by OSHA regulations.
[5] SCREEN3 is publicly available at http://www.epa.gov/scram001/dispersion_screening.htm
[6] NAAQS available at http://www.epa.gov/air/criteria.html

study, the modeling area was defined as the region from 0 to 1,500m (just under a mile) from the center of the source to ensure that the 50th percentile distance listed above would be included. In addition, there is a user option to specify discrete distances. These are specific distances from the center of the source where the user can request SCREEN3 to estimate maximum concentrations. This specific distance is the distance to the receptor that is chosen from the distribution in Table 3 above.

Table 4 – Input parameters for SCREEN3

Parameter Description	Value
Source type	Area
Emission rate ($g/s\text{-}m^2$)	0.000243[1]
Height of storage pile (m)	0
Length of storage pile (m)	Variable[2]
Width of storage pile (m)	Variable[2]
Receptor height (m)	1.75
Urban or Rural	Rural
Search for maximum direction	Yes
Choice of meteorology	Full
Automated distance array	Yes
Minimum distance (m)	0
Maximum distance (m)	1500
Use discrete distances	Yes
Distance (m)	Variable[3]

[1] Calculated using the workbook (U.S. EPA, 1992)
[2] Based on EPRI landfill size data (EPRI, 1995)
[3] Based on landfill to well distances (U.S. EPA, 1988)

2.5 SCREEN3 Outputs

Using the inputs listed in Table 2, 3, and 4, SCREEN3 was used to estimate the concentration of CCW in the air at ground level under the windblown erosion scenario. After running the model with both 50th percentile values plugged in, a result of 13,390$\mu g\ m^{-3}$ was obtained. Since the values generated by SCREEN3 are maximum values, they should be compared to the 24-hour NAAQS. However, even under the assumption that 100% of the CCW was PM_{10}, this would still violate the 24-hour NAAQS for PM_{10} of 150 $\mu g\ m^{-3}$ by nearly two orders of magnitude. This indicates that the risks posed by fugitive dust cannot be screened out if no dust controls are applied before closure, and therefore it was unnecessary to run the screen with other percentiles.

3.0 Secondary Scenarios

Given that the risks of uncontrolled fugitive dust emissions could not be screened out, the next logical question was whether or not the risks given particular management options could be screened out. Perhaps covering or spraying the CCW on a regular basis to prevent emissions could be adequate to protect human health. The appropriate question then is how frequently these controls should be applied to ensure the NAAQS are not exceeded. Some possible time frames might be yearly, monthly, weekly, and daily. To model these scenarios, caveats and additional information are required. First, assuming that a landfill is operated consistently over its life time, the life will affect how much of the landfill is being used over any period of time. In a previous groundwater risk assessment, EPA estimated that the operating life of a CCW landfill is 40 years (U.S. EPA, 1998a). EPA believes that this is still an accurate estimate, and thus, it is assumed for this assessment that all landfills will operate for 40 years. Since a landfill is assumed to operate consistently over a 40-year life, then the area of the landfill that is operated during any year can be stated as:

$$A_{yr} = \frac{A_{total}}{40}$$

where:

A_{yr}	=	the area of the landfill in use over a year (m^2)
A_{total}	=	the total landfill capacity (m^2)
40	=	life of a CCW landfill (N/A)

Once the portion of the WMU used over a single year is estimated, then it is also possible calculate the area of the landfill used monthly, weekly, and daily as follows:

$$A_{month} = \frac{A_{yr}}{12} \qquad A_{wk} = \frac{A_{yr}}{52} \qquad A_d = \frac{A_{yr}}{365}$$

where:

A_{month}	=	the area of the landfill in use over a month (m^2)
A_{wk}	=	the area of the landfill in use over a week (m^2)
A_d	=	the area of the landfill in use over a day (m^2)
A_{yr}	=	the area of the landfill in use over a year (m^2)
12	=	the number of months in one year (N/A)
52	=	the number of weeks in one year (N/A)
365	=	the number of days in one year (N/A)

Performing these calculations on each percentile from Table 2 above, the areas and side lengths for the portion of the WMU operated over each period of time is as follows:

Table 5 – Area (m^2) and Side (m) Distributions

	Yearly		Monthly		Weekly		Daily	
%ile	Area	Side	Area	Side	Area	Side	Area	Side
50th	6,728	82.0	561	23.7	129	11.4	18	4.3
60th	8,600	92.7	717	26.8	165	12.9	24	4.9
70th	12,282	110.8	1024	32.0	236	15.4	34	5.8
80th	21,084	145.2	1757	41.9	405	20.1	58	7.6
90th	30,109	173.5	2509	50.1	579	24.1	82	9.1

All values based on assumption that a WMU operates consistently for 40 years.

Table 8 – SCREEN3 Outputs (μg m^{-3}), Daily Fugitive Dust Controls

	Distance to Nearest Receptor				
Landfill Size	**50th**	**40th**	**30th**	**20th**	**10th**
50th	5.4	6.4	7.6	11.3	15.7
60th	6.5	7.6	8.9	13.0	17.6
70th	8.1	9.2	10.7	15.1	19.7
80th	11.3	12.7	14.3	19.0	23.6
90th	13.9	15.42	17.2	21.9	26.4

See Appendix D for raw inputs and outputs.

4.0 Results and Discussion

As seen in Tables 6, 7, and 8, the risks posed by fugitive dust inhalation could not be screened out for every management time frame. However, certain conclusions can be drawn for each management consideration. The discussion of each time frame is below, but should be interpreted with several overarching uncertainties in mind.

- The SCREEN3 model is a conservative screening model. Thus, in most instances, the levels of particulate matter calculated here are likely higher than they actually would be.

- As the area of the landfill exposed to wind erosion decreases due to more frequent controls, unloading emissions would become a much more significant proportion of total emissions. Hence, the more frequently controls are used, the more important it would be to include unloading emissions to calculate an accurate concentration.

- Background levels of particulates were not factored into these calculations. Thus, the particulates calculated here could actually underestimate total particulates.

- The distances to the nearest receptor are not based on recent CCW landfill survey data and may therefore lead to an underestimate or overestimate of particulate levels.

- In the secondary scenarios, the operating portion of the landfill was assumed to be in the center of the landfill and not on the downwind edge. This may lead to an underestimate of particulate levels when that edge portion is used.

- A single emission factor was calculated based on national default inputs. For particular sites, the calculated emission factor could be higher or lower.

Finally, there are a few general trends between the inputs and outputs examined in Appendix C. With respect to the location of WMUs, those located in rural settings will cause much higher particulates concentrations than those in urban settings. Since a rural setting was assumed here, it is possible that some WMUs would present much lower risks to human health through the inhalation of fugitive dust. In addition, it was shown that landfills that are built up, as opposed to dug into the ground, would actually lead to lower particulates concentrations nearby. Thus, in the case of built up landfills, nearby residents would be presented with less risk than what was modeled here. However, receptors may be at ground level, presenting slightly higher risks.

4.1 Controls Applied Yearly

Even at the median risk, yearly management leads to a PM_{10} concentration almost an order of magnitude above the NAAQS. Although larger landfills and closer receptors were not modeled, they would have resulted in even higher exceedences. Therefore, controls applied only at the end of each operating year fail the screen, and have the potential to pose a significant risk to human health.

4.2 Controls Applied Monthly

At the median risk, monthly management leads to a PM_{10} concentration barely above the NAAQS. Although larger landfills and closer receptors were not modeled, they too would have resulted in exceedences. Consequently, controls applied each operating month fail the screen as run, and have the potential to pose a significant risk to human health. .

4.3 Controls Applied Weekly

At the median risk, weekly management did not exceed the NAAQS for PM_{10}. Only if most or all of the particulates were $PM_{2.5}$ would there be any exceedance. However, this is not the case because CCW typically consists of only a few percent of $PM_{2.5}$ (EPRI, 1995). When larger landfills and closer receptors were modeled, most did not result in excess risk. Only when receptors were within the closest 10% of the distribution (within about 100m), and landfill sizes were large (over about 200 acres) did levels above the NAAQS result. Thus, in isolation, it is relatively likely that the median would not lead to excessive levels of particulates but that the upper tail could. Thus, the results are mixed, and it is uncertain whether these emissions alone would have the potential to pose a significant risk to human health.

4.4 Controls Applied Daily

At the median risk, daily management did not exceed the NAAQS for PM_{10} or $PM_{2.5}$. Even when larger landfills and closer receptors were modeled, most concentrations fell well below the NAAQS. Taken in isolation, it is certain that neither the median nor the upper-tail scenario would lead to excessive levels of particulates. Thus, without considering background levels, a weekly fugitive dust control would be sufficient to protect human health.

5.0 Conclusion

The purpose of this screening assessment was to determine whether the NAAQS could be violated through dry handling of CCW, and if so, what management options might be appropriate. Indeed, it was found that there is not only a possibility, but a strong likelihood that dry-handling would lead to the NAAQS being exceeded absent fugitive dust controls. Yearly and monthly controls were also found to have the potential to lead to significant risks. However, with this screen, it was uncertain whether weekly controls would have the potential to cause NAAQS exceedences, and even the most conservative evaluation of daily dust controls led to particulate concentrations well below the NAAQS. Thus, without further, more precise evaluation, only daily controls can definitively be said not to cause excess levels of particulates in isolation.