Stormwater Runoff Water Quality Science/Engineering Newsletter Devoted to Urban/Rural Stormwater Runoff Water Quality Management Issues

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This issue of the Stormwater Runoff Water Quality Science/Engineering Newsletter (NL) is devoted to a discussion of an approach for **evaluating the potential stormwater runoff and groundwater recharge impacts on public health and the environment associated with chemicals (dust suppressants) used to control dust from dirt roads and vacant/developing properties.** There is increasing concern by some federal, state and local air quality regulatory agencies about the control of dust as an air pollutant. In addition to the dust being an aesthetic nuisance, it is also a human health hazard. This has led to the use of a wide variety of chemicals, including wastes, applied to roads and properties to attempt to control dust emissions. This application of chemicals to dirt roads and lands is receiving increasing attention as a potential source of water pollution in stormwater runoff from the areas where the dust suppressants are applied. At this time little regulatory attention is being given to the stormwater runoff water quality impacts of chemicals used as dust suppressants. This Newsletter presents a review of this issue, including a recommended approach for evaluating the potential for chemicals applied as dust suppressants to cause public health and/or environmental problems.

Engle (2004), in a recent article, "Bidding Farewell to Dusty Roads," which appeared in the January/February issue of *Erosion Control*, has provided an overview discussion of some aspects of the use of chemicals as dust suppressants. As he discusses, there are a variety of chemicals and approaches used for this purpose. These include frequent watering, proprietary chemicals of various types, lignins, chlorides, various types of emulsions (including pitch and resin emulsions), polymers, petroleum hydrocarbons, etc. The Internet, in a search for "dust suppressant," shows over 500 "pages" of listings, a number of which are devoted to specific chemicals.

In May 2002 the US EPA, through the University of Nevada, Las Vegas, Department of Civil and Environmental Engineering (Dr. Thomas Piechota), conducted an Expert Panel meeting to evaluate potential environmental impacts of chemicals/materials used as dust suppressants on roads, developing properties and other areas. Dr. G. Fred Lee was an invited participant on the Expert Panel.

The Expert Panel's discussion of these issues was developed into a draft report (Piechota, et al., 2004), "Potential Environmental Impacts of Dust Suppressants: 'Avoiding Another Times Beach,'" that is currently under review by the US EPA. The reference to Times Beach is made since it was chemical manufacturing wastes that contained dioxins that were used as dust suppressants in Times Beach, Missouri. This led to a US EPA Superfund site designation for the area where the chemical manufacturing wastes were used as dust suppressants. The Expert Panel report provides background information on the use of various types of chemicals and materials, including wastes, as dust suppressants. One of the areas of particular concern was the lack of guidance on how to evaluate the use of various types of chemicals as dust suppressants for their potential impacts associated with stormwater runoff from the areas in which the dust suppressants are applied.

Following the Expert Panel meeting, Drs. G. Fred Lee and Anne Jones-Lee developed guidance on the approach that they feel should be followed to evaluate the potential for dust suppressant chemicals to cause public health and environmental problems associated with stormwater runoff from the areas of application. Presented below is this recommended approach. This presentation does not represent an endorsement of this approach by the Expert Panel, since this approach was developed after the Panel convened.

The authors' expertise and experience, which serve as the basis for the guidance presented below, are primarily focused on evaluating surface water and groundwater quality impacts of chemicals that are disposed of or used in a manner that could lead to environmental pollution.

Evaluation of the Potential Water Quality Impacts of Dust Suppressants[1]

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Presented below is a summary of the overall approach that should be used to determine whether dust suppressants represent a potentially significant environmental threat through their impacts on surface water and/or groundwater quality. The focus of this discussion is on adverse impacts to aquatic life in the receiving waters for runoff from areas that have received application of dust suppressants, as well as groundwaters in which dust suppressants have migrated from the point of application to the water table and, therefore, are a potential threat to those who use the groundwater for domestic or agricultural purposes.

Evaluation of the potential environmental impacts of the constituents in dust suppressants is difficult to do reliably, since some of the dust suppressants that are being used are waste materials which are poorly characterized, which are variable from batch to batch, and for which there is limited information today on the potential impacts of the constituents in the waste mixture. This situation mandates that a much more careful approach be used for evaluating the potential impacts of dust suppressants, especially under conditions where there is repeated application of a dust suppressant to a particular location.

The Times Beach dioxin situation is an example of the use of a waste material as a dust suppressant which led to significant environmental and public health problems. There are others. For example, as reported by Lee and Jones-Lee (2002a), in the Sierra-Nevada Mountains in California, PCB-based transformer oils were used as dust suppressants on some mountain roads.

[1] Report prepared for Expert Panel on the "Potential Environmental Impacts of Dust Suppressants," organized by the University of Nevada, Las Vegas, Department of Civil and Environmental Engineering (2003).

This led to significant excessive bioaccumulation of PCBs in fish of the region downstream for many miles from where the PCB dust suppressant was applied. There are likely many more situations of this type, which have simply not been adequately investigated and/or documented.

Surface Water Quality Impact Evaluation

Evaluation of the impact of a chemical on surface water quality typically focuses on impacts on aquatic life and impacts on the use of waters for domestic water supply. With the exception of a few chemicals of concern because of agricultural use of the water, such as boron, chemicals that do not have adverse impacts on aquatic life and/or human health are generally considered "safe" for other beneficial uses of the water. A suggested evaluation approach for each of these beneficial uses is presented below.

Domestic Water Supply. The impacts of a chemical on domestic water supply water quality are of concern from two perspectives, one of which is human health, where the concentrations of the chemical in a water used for domestic water supply are a threat to the health of those who consume the water. The other potential impact is on the non-human-health impacts of chemicals. The US EPA and some state agencies, like the California Department of Health Services, have established maximum contaminant levels (MCLs) for a number of chemical constituents that have been found or have the potential to be found in domestic water supplies at concentrations that impair the use of the water for domestic purposes. The current Clean Water Act regulatory approach assumes that if a water has a classified designated beneficial use as a domestic water supply, then the presence of a chemical above an MCL is an impairment of use that must be corrected, independent of whether there is a domestic water supply intake in the vicinity of where the chemical is found. Evaluation of whether a chemical in a dust suppressant is a significant threat to domestic water supply water quality requires that a determination be made as to whether waters that are or could be used for domestic purposes contain concentrations of the chemical above the federal and/or state maximum contaminant level. In making this evaluation, a worst-case-based monitoring program should be conducted to determine whether any of the constituents that are present in the dust suppressant could occur in receiving waters for runoff from the area of application at concentrations above the MCLs.

The US EPA and the state regulatory agencies have listed MCLs for only a few of the many thousands of chemicals that are potential threats to domestic water supplies from a human health perspective. There are about 85,000 chemicals in use today. Only about 100 or so have MCLs. Periodically the regulatory agencies are adding new chemicals to the list of regulated chemicals.

From a human health perspective, the primary issue is whether a chemical in a dust suppressant is a potential threat either to cause cancer in those who consume water contaminated by it or to be toxic to human health. With respect to cancer, the issue is primarily that of achieving a regulatory mandated "acceptable" risk of acquiring cancer associated with the consumption of water. Typically, the acceptable risks today range from one additional cancer in 100,000 people or 1 million people who consume 2 liters of the water per day over their lifetime.

A second area of concern with respect to impacts of dust suppressants on domestic water supplies is whether they cause the water to contain sufficient concentrations of a chemical(s) to adversely affect the use of the water for domestic purposes, such as through causing tastes and odors, color, turbidity, increased corrosion and/or scaling of plumbing and/or distribution systems. The US EPA and state agencies have secondary MCLs for some of the chemicals or properties that are adverse to the use of a water for domestic purposes. The runoff waters from an area where dust suppressants are applied need to be evaluated with respect to these MCLs. This evaluation should be based on worst-case application situations for these types of problems.

Adverse Impacts on Human Health through Excessive Bioaccumulation

A second route of exposure for humans that is of concern in evaluating the potential for a chemical(s) in dust suppressants to be adverse to public health is through excessive bioaccumulation of the chemical in aquatic life that would cause fish and other edible aquatic organisms to be a risk to human health. Dioxins, PCBs, and organochlorine pesticides are examples of these types of chemicals.

In situations where a particular type of dust suppressant has been applied repeatedly over the years, where there is little doubt that some of it has run off to nearby streams, fish from these streams should be examined to determine if they contain any of the regulated chemicals that are known to be a threat to human health. The US EPA (2000), as part of the California Toxics Rule, and, more recently, with its updated National Recommended Water Quality Criteria: 2002 (US EPA, 2002a), has provided guidance on critical concentrations of chemicals in water which can bioaccumulate to excessive levels in aquatic organisms. These criteria should be used to determine if there is a potential for excessive bioaccumulation.

Another approach that is used to evaluate the potential for excessive bioaccumulation is to take samples of either the sediments that have received runoff from an area of treatment or, in the case of dust suppressants, the roadway, where it is likely that there will be transport of the dust-suppressant-treated soils to nearby watercourses. The testing procedure should be similar to that used by the US EPA and the Corps of Engineers (US EPA/US COE, 1991) to evaluate whether chemicals in dredged sediments represent a threat to cause excessive bioaccumulation in the water where the dredged sediments are deposited.

The current regulatory agencies' listing of chemicals that tend to bioaccumulate to excessive levels represents a small part of the total arena of chemicals that could be present in dust suppressants and could bioaccumulate to excessive levels. As part of evaluation of a particular dust suppressant, efforts should be made to determine if there are any unknown peaks in a GCMS examination of a fish tissue that has been exposed to the dust suppressant. If GCMS scans shows unidentified peaks, then studies should be conducted to characterize the chemicals responsible for these peaks. If information is not available for the chemicals on toxicity to humans and aquatic life, then studies should be done to determine adverse effects to humans and aquatic life.

Evaluation of Potential Impacts to Aquatic Life

The primary impact of concern with respect to dust suppressants to aquatic ecosystems is the toxicity to aquatic life of the chemicals in the dust suppressant or of these chemicals when combined with chemicals from other sources. There are basically three types of situations of concern. One is direct toxicity through absorption of the chemical. The second is the accumulation of a body burden of the chemical(s), which then causes toxicity to that organism or to higher-trophic-level organisms. The third is the production of tumors or other adverse effects in aquatic life.

Tumor Induction. With respect to dust suppressants containing compounds which cause tumors in aquatic life, petroleum-derived constituents are known to cause tumors in aquatic life. In order to investigate this situation, it is necessary to conduct long-term exposure studies under situations such as in ponds (mesocosms) which simulate the conditions that could occur in the environment. Further, aquatic life such as clams in streams that are receiving runoff from areas treated by dust suppressants should be periodically examined to determine if the incidence of tumors is higher in the region where the runoff from the areas where dust suppressants have been applied occurs, compared to other similar habitat regions that do not receive the dust suppressant.

Excessive Body Burdens. There are two sources of information on what constitutes an excessive body burden in aquatic life for various types of chemicals. Jarvinen and Ankley (1999) have published a review, *Linkage of Effects to Tissue Residues: Development of a Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals*. This publication presents a comprehensive, critically-reviewed, literature-based assessment of the concentrations of chemicals found in aquatic organisms relative to observed effects on the organisms. The Jarvinen and Ankley (1999) database has well over 3,000 entries for 200 chemicals, and is based on 500 references. The Jarvinen and Ankley toxicity/residue database as published by SETAC press is available in an Access database format at the web site http://www.epa.gov/med/databases/tox_residue.htm.

As part of developing regulatory approaches for disposal of contaminated dredged sediments, the US Army Corps of Engineers (US COE, 1997) developed "The Environmental Residue-Effects Database (ERED)." This database is a compilation of information on the concentrations of chemicals in aquatic organism tissue and their apparent effects on aquatic life. The ERED is available electronically from http://ered1.wes.army.mil/ered/index.cfm. It was last updated June 2001. It now contains 3,463 results of 736 studies on 188 species for 222 analytes.

As with excessive concentrations that are a threat to human health, the fish tissue residues should be examined for unidentified GCMS peaks, and an assessment should be made as to whether the chemical that is found to bioaccumulate in aquatic life where dust suppressants have been used, which is traceable back to the dust suppressant as a source, is of potential significance as a cause of adverse effects to aquatic life through bioaccumulation in the host or higher-trophic-level organisms that use the host organism as food.

Aquatic Life Toxicity. Many chemicals at relatively low concentrations can be toxic to certain forms of aquatic life. The standard procedure that has evolved for evaluating this situation is through laboratory-based toxicity tests using the US EPA (2002b,c) three freshwater species: fathead minnow larvae, the zooplankton *Ceriodaphnia* and the alga *Selenastrum*. All dust suppressants should be tested for their aquatic life toxicity using these three species at concentrations of the dust suppressant which are representative of worst-case conditions that could occur in the environment. For situations where the runoff from areas that have received dust suppressants is to marine waters, the US EPA (2002c,d) aquatic life toxicity testing procedures should be used, as well as additional procedures described in US EPA/US COE (1991). Both acute and chronic toxicity should be evaluated. Since it is not possible to reliably measure under laboratory conditions low levels of toxicity that can occur in the environment, for information for which the US EPA has developed water quality criteria, the US EPA's (2002a) recent update of water quality criteria should be examined for the presence of chemicals at concentrations above the criterion values. Exceedance of the criterion value for those chemicals that are potentially toxic to aquatic life is presumptive toxicity which must be regulated as toxicity.

There are many factors that tend to cause potentially toxic chemicals to be nontoxic. Therefore, the manufacturer/user of a dust suppressant that contains chemicals for which there are water quality criteria of potential concern with respect to causing toxicity may wish to conduct the necessary studies to determine whether the use of a particular dust suppressant in a certain situation leads to aquatic life toxicity. If no toxicity is found, there is justification for site-specific objectives for the dust suppressant chemicals. Additional information on this issue has been provided by Lee and Jones-Lee (2002b).

In addition to water column toxicity, there is need to evaluate whether the dust suppressant contains chemicals which would bind to sediments and thereby be toxic to benthic organisms. The standard US EPA (1994) toxicity test using *Hyalella azteca* should be used to evaluate this type of situation. The dust suppressant should be mixed with the road or other materials derived from the area receiving the dust suppressant which could be transported to a watercourse, and evaluated under laboratory conditions to determine if *Hyalella*, the standard sediment toxicity organism, is affected by the sorbed and dissolved dust suppressant.

The same test should be used to determine if the chemicals in the sorbed dust suppressant are taken up by benthic organisms. The US EPA (1994) standard bioaccumulation test organism *Lumbriculus variegatus* should be used for this purpose, on realistic, worst-case samples of the material.

Excessive Fertilization. Another type of impact of concern associated with the use of dust suppressants is the addition of aquatic plant nutrients (nitrogen and phosphorus compounds), which stimulate the growth of algae and/or other plants in the receiving waters for the dust suppressant runoff. Dust suppressants need to be evaluated with respect to whether they contain nitrogen and phosphorus compounds in an algal available form or in forms that could convert to available forms under ambient receiving water conditions. If such compounds are detected, then an evaluation should be made as to whether the amount of nitrogen and/or phosphorus added to the waterbody from dust suppressant use would stimulate further algal growth within the waterbody. Consideration must be given not only to the waterbody immediately receiving the dust suppressant runoff, but also downstream waterbodies, especially ponded waters, since lakes, reservoirs and ponds tend to be much more sensitive to nutrient loads than flowing waters. Lee and Jones-Lee (2002b,c,d) provide guidance on evaluation of the potential significance of nutrient discharges to waterbodies.

Groundwater Pollution

Chemicals in dust suppressants have the potential to cause the pollution of groundwaters, rendering them unusable for domestic and some other purposes. The potential for dust suppressants to cause groundwater pollution needs to be evaluated as part of any approval process for the use of dust suppressants. There are several factors that need to be considered in conducting this evaluation, one of the most important of which is the characteristics of the unsaturated and saturated groundwater regime underlying the areas where the dust suppressant will be applied and where runoff from the application area could lead to groundwater pollution.

The application of dust suppressants to areas with a non-fractured clay geological system underlying the area of application would represent little or no potential for groundwater pollution. However, their application to areas where the underlying aquifer system is sand and gravel, fractured rock, or fractured or cavernous limestone could readily result in substantial pollution of the groundwaters of the region. As a result, it is necessary to understand the hydrogeology of the area in which the dust suppressants are applied, or where runoff from the areas of application could lead to areas of infiltration into the groundwater system under the region. While ordinarily, the impacts on groundwater quality are evaluated in terms of exceeding either the primary or secondary maximum contaminant level (MCL) for the use of the water for domestic purposes, there are situations where shallow groundwaters could be polluted by dust suppressants that lead to surface water contamination through discharges in springs to the surface or through subsurface discharges in streams, lakes and other waterbodies. It is, therefore, important to understand the hydrogeology of the area.

A key issue in evaluating the potential for groundwater pollution is the determination of the mobility of dust suppressant chemicals in an aquifer system. Of particular concern is whether the aquifer contains significant amounts of silts or clays which can serve as sorption sites for chemicals that tend to sorb (attach), such as the larger organic molecules or inorganics that tend to precipitate in the aquifer. It is important not to assume, as some erroneously do, that a deep water table means that groundwater cannot be polluted. The depth of the water table, for mobile constituents, is only a time factor. Eventually, the groundwaters can be polluted if the dust suppressant contains constituents that are mobile in the aquifer system and that can be adverse to the beneficial use of the groundwater.

Repeated application of a dust suppressant that has the potential to cause groundwater pollution should require that those responsible for the application of dust suppressants conduct a monitoring program to evaluate whether groundwater pollution is occurring or could occur. The monitoring system that should be used should include monitoring of the groundwaters at the most likely point where incipient groundwater pollution would occur at the water table. This should involve monitoring wells just downgradient of where the dust suppressant chemicals are likely to infiltrate. This monitoring should generally focus on sampling the water table area in the upper few feet of the water table. An exception to this would be for situations where there is sufficient salt in the dust suppressant to lead to the infiltrating water having a higher density than the aquifer water. Density gradients in the aquifer would lead to greater penetration into the aquifer.

Ideally, unsaturated (vadose) zone monitoring should be conducted, in which vacuum cup lysimeters are used under the areas where the dust suppressant is applied. Lee and Jones-Lee (2002b) provide a discussion of the unsaturated zone monitoring approach. There are some who attempt to model unsaturated transport of constituents based on average annual moisture content of the vadose zone. Such an approach is obviously incorrect in light of the fact that the majority of the transport in the vadose zone occurs in a wetted-front transport associated with precipitation events. Modeling efforts based on average annual moisture content grossly underestimate the rate of transport of constituents in the vadose zone to the groundwater table.

Another significant error that is frequently made in attempting to model the transport of pollutants through the vadose zone is the use of pure solution distribution coefficients. The tendency for sorption based on octanol water partition coefficients on organic carbon particles or inorganic particles with organic coatings may have little or nothing to do with the real sorption tendencies of organics and inorganics that are derived from waste mixtures. The constituents of concern can form complexes, associations, or colloidal particles, all of which will behave differently than would be predicted based on pure solution distribution coefficients. Some of these would tend to slow down the rate of transport through the vadose zone as a result of enhanced sorption tendencies. Other interactions between the dust suppressants and other chemicals would tend to accelerate transport, since the constituent would not be sorbed as strongly as predicted based on pure solution situations. The net result is that it is virtually impossible to reliably predict, through modeling, the transport of constituents applied to soil from a place of application to the groundwaters, under conditions where the constituents of concern are derived from complex mixtures of chemicals, such as a number of the constituents in waste-derived dust suppressants that are used today.

Application of Results to Dust Suppressant Evaluation

There are basically two approaches that should be used. One is a pre-use evaluation, where the dust suppressant is used to treat, in a realistic simulated situation, representative areas to which the dust suppressant would be applied, and various tests are conducted to determine whether the dust suppressant causes any of the potential problems discussed herein. Since the pre-testing could not possibly cover all of the conditions of concern, a post-application monitoring program should be conducted, where the first few times that the dust suppressant is applied in a particular area, various tests and various test procedures discussed above should be used, where the emphasis is on monitoring any drift through airborne transport, as well as application that occurs outside of the target area. Further, the runoff from the "first flush" situation associated with a major storm should be monitored for potential impacts. This monitoring should focus on water column and benthic organism toxicity.

Repeated application of a dust suppressant to an area should require that those applying the dust suppressant conduct ongoing monitoring programs of the area. Particular attention should be given to changes in aquatic organism assemblages, using bioassessment techniques, such as those developed by the US EPA, where the numbers and types of organisms present in the area receiving dust suppressant runoff are compared to areas with similar habitat characteristics that have not received dust suppressants (see Barbour, *et al*., 1999, and DFG, 2003).

Since the proper evaluation of the potential environmental impacts of a dust suppressant requires expertise in a number of disciplines, it is suggested that the regulatory agency appoint an expert panel who would conduct the review of a dust suppressant application. The panel members should have expertise in the various areas of concern. Further, since in general definitive yes/no answers will not likely be obtained in some – perhaps many – aspects of the evaluation, it is suggested that a best professional judgment triad weight of evidence approach be used, in which an expert panel would weigh the evidence and make a decision on whether the use of a particular dust suppressant could represent a potential threat to public health and the environment. Lee and Jones-Lee (2002e) have discussed the use of the best professional judgment triad weight of evidence approach for evaluating the water quality significance of chemical constituents associated with aquatic sediments. This approach can also be used for dust suppressants associated with soils to which they have been applied.

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