DEPARTMENT OF AGRICULTURE
MINNESOTA

Results of 1996 Soil Sampling of Pesticides on Crop Production Retailer Facilities

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1996 Soil Sampling Report
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Executive Summary

In 1996, the Minnesota Department of Agriculture (MDA) conducted a soil sampling program on agricultural crop production retailer facilities, to determine if and to what extent the facility soils were being affected by pesticides, and to evaluate the success of recent advancements in improved facility management practices and bulk pesticide containment.

In 1989, data concerning the potential for leaching of pesticides to ground water became widely available. In response to this information, Minnesota crop production retailers improved their pesticide handling practices significantly. This shift in awareness also resulted in the promulgation by the MDA of new and more stringent bulk pesticide storage rules. Using 1989 as the baseline year and pesticides registered for use in Minnesota since that time, the 1996 sampling plan was designed to provide a "before and after" comparison, to evaluate if soil pesticide contamination was still occurring at Minnesota crop production retailer facilities.

Thirty agricultural chemical facilities were selected at random by MDA staff for soil sampling during a short timeframe in late summer 1996. A short timeframe reduced the temporal variability of the sampling and reduced disruptions to active businesses. The soil sampling at each facility focused on five general locations or areas that are at high risk for pesticide contamination. These areas include: 1) the small package product mix and load area; 2) the bulk pesticide mix and load area; 3) the fertilizer impregnation area; 4) the water filling station, and 5) obvious runoff areas with stressed vegetation.

Composite samples were collected from zero to six inches in each area and analyzed by the MDA Laboratory Services Division for base neutral (MDA List 1) pesticides and sulfonylurea pesticides. The analysis list included several pesticides registered after 1989. Some commonly used pesticides, including the imidazolinones, were not included in the 1996 soil sampling because laboratory analytical methods were not available to the MDA. A number of different pesticides were detected, including pesticides registered after 1989. The ten pesticides most frequently detected are shown in the table below, along with their registration date, number of detections in the soil samples, the range of pesticide concentrations detected and the average value detected.

Chemical Detected and Registration Date	Number of Detections	Range of Concentrations Detected (mg/kg)	Average of Values Detected (mg/kg)*
Metolachlor *(Dual) Pre1989*	66	< 0.1 - 428	7.93
Pendimethalin *(Prowl) Pre 1989*	57	< 0.1 - 38.6	1.54
Acetochlor *(Harness/Surpass) 1994*	55	< 0.1 - 81.6	1.84
Alachlor *(Lasso) Pre 1989*	55	< 0.1 - 91	3.27
Trifluralin *(Treflan) Pre 1989*	51	< 0.1 - 81.9	3.67
Atrazine *(Aatrex) Pre 1989*	38	< 0.1 - 20.5	0.49
Nicosulfuron *(Accent)1990*	36	< 0.001 - 0.071	0.005
EPTC *(Eradicane) Pre 1989*	21	< 0.1 - 1.8	0.09
Prometon *(Pramitol) Pre 1989*	20	< 0.11 - 0.59	0.05
Triallate *(Far-go) Pre 1989*	14	< 0.1 - 369	4.08

* Average values were calculated assuming a non-detect was equal to zero, thus some averages appear lower than the range of concentrations detected.

Of the thirty facilities sampled for this project in 1996, pesticides were detected at 28 facilities. Of these 28 facilities, 23 had at least one detection of a post-1989 pesticide. A total of 93 soil samples were collected from the thirty different facilities. Pesticides were detected in 84 of the samples. Of the 93 samples taken, 68 percent of the samples (64 samples) had detections of pesticides registered after 1989. Pesticides were detected at each of the five high risk areas targeted for investigation. The greatest number of pesticide detections occurred in the bulk pesticide mix and load areas. The lowest number occurred in the small package mix and load areas. All five areas had detections of post-1989 registered pesticides.

The soil data from all 30 facilities were evaluated by the MDA prioritization procedure to determine if the site required further investigation and possible cleanup. Sixteen facilities were determined to require no further investigation or cleanup based on the available data. The remaining fourteen facilities were either placed on the MDA priority list or entered the MDA voluntary cleanup program.

Several facility managers were interviewed by telephone by MDA staff after the actual soil sampling results were reported. Various potential sources for contamination were identified, including: tires tracking pesticides off of load pads; spilled material being swept outside and/or off of pads; the accumulation of small spills; washing of equipment; wind blowing impregnated fertilizer off of load pads; and overfilling of equipment by customers unsupervised by facility personnel.

The report discusses management practices to reduce contamination based on telephone interviews of managers at facilities with both high and low detections. Practices identified by facility managers to prevent releases were: sweeping frequently or daily, having a plan in place to manage sweepings, cleaning up small spills immediately, having wind control devices for impregnation areas, and generally allowing water fill stations to be accessed by facility employees only. Wind control devices identified for impregnation areas included several options from the installation of downspouts to enclosing the impregnation load area within a building.

Based on the results of the 1996 soil sampling, current Minnesota bulk pesticide storage rules are an excellent baseline regulation, helping to level the playing field for competition and preventing contamination from large releases. However, the sampling results indicate that the bulk storage facilities are not completely effective without proper management or adequate housekeeping. In addition, installation of capital improvements are also beneficial, but effectiveness depends on careful evaluation by the retailer for each situation.

Preventing soil contamination on the crop production retailer facilities will provide several benefits to the retailer, including avoidance of cleanup costs, less regulatory oversight, averted liability for off-site health or environmental affects, and less shrinkage costs from lost product. Communication of specific contamination prevention techniques should be increased to achieve this end. This will take a concerted effort from MDA and, especially, the agricultural chemical industry itself.

Introduction

In 1996, the Minnesota Department of Agriculture (MDA) conducted a soil sampling program on agricultural crop production retailer facilities, to determine if and to what extent the facility soils were being affected by pesticides, and to evaluate the success of recent advancements in improved facility management practices and bulk pesticide containment.

Historical perspective. In 1989, the Minnesota Ground Water Protection Act was passed in light of surveys showing that pollutants, including pesticides, were affecting ground water. Ground water contamination from pesticides resulted from both non-point sources, such as normal field use, as well as point sources, including handling operations or spills at crop production retailer facilities.

Agricultural chemicals are commonly sold throughout the midwestern United States by crop production retailers who store and sell pesticides in bulk or smaller quantities. These businesses may also commercially apply these pesticides for growers. Crop production retailers in Minnesota are often major contributors to local rural economies, economies upon which the businesses themselves depend. Because of this interrelationship, retailers are often concerned about environmental effects their business practices may have on local water and other natural resources. When information about the detrimental effects of pesticides on ground water became widely available in 1989, crop production retailers improved their pesticide handling practices significantly.

This shift in awareness also resulted in the promulgation by the MDA of new and more stringent bulk pesticide storage rules. As a result of these rules, most of the Minnesota bulk pesticide storage facilities were constructed between 1990 and 1992. These safeguard requirements include concrete floors, dikes and pads for the storage and mixing/loading of bulk pesticides. Many of the bulk storage facilities in Minnesota are now inside roofed buildings.

As a part of the 1989 Minnesota Ground Water Protection Act, the state agricultural chemical pesticide control laws were restructured and expanded. MDA began a program to investigate and clean up crop production retailer facilities and other sites affected by agricultural chemicals. File records from the MDA's Comprehensive Facility Site Cleanup Program have shown that historical contamination of soils on crop production retail facilities can result in a point source for agricultural chemical contamination in ground water. As of August 1997, the records indicate that 59 facilities undergoing investigation and cleanup are underlain by shallow groundwater with detectable levels of agricultural chemicals. A total of 22 drinking water wells, both on and off the facility sites, have been contaminated by agricultural chemicals originating from these facilities. Of these wells, 18 contained contaminants above drinking water standards as established by the Minnesota Department of Health.

To assist with these cleanups, the Ground Water Protection Act also created the Agricultural Chemical Response and Reimbursement Account, better known as the ACRRA fund. The fund was established primarily for partial reimbursement of investigation and clean up costs of facilities and other sites contaminated with agricultural chemicals. Reimbursement is contingent on several factors, including whether the costs were reasonable and necessary, the actions were approved by the MDA, and whether the spill was properly reported as required by law. However, the appointed board overseeing the ACRRA fund realized that most larger cleanups resulted from the accumulation of unaddressed spills over a period of years, sometimes decades, prior to 1989. Such releases or incidents were designated as "historical" contamination, which did not necessarily require the same sort of immediate reporting as did emergency, contemporaneous spills to ensure reimbursement eligibility.

New data. Since the 1970's, staff from the Minnesota Department of Agriculture has conducted soil sampling at businesses that handle agricultural chemicals for various reasons, including spill response, complaint follow-up, etc. Several such samples taken in 1995 indicated the presence of acetochlor in the soil. Acetochlor was registered for use in Minnesota in 1994, and its presence in recent facility soil samples indicated that pesticide contamination on facilities had not been completely prevented by the new bulk pesticide regulations and the improved practices of retailer facility personnel.

The MDA staff was concerned that newly registered pesticides were detected in soil and water samples collected at retailer facilities, even those constructed to meet the 1989 MDA bulk pesticide storage rules. In addition, the ACCRA Board was also concerned about the presence of newly registered pesticides in samples collected at new storage facilities, many of which cost several hundred thousand dollars to construct. The Board expressed support for MDA staff efforts to explore this issue.

Intent of soil sampling. In order to determine if recent contamination of retailer facilities was an important issue, the MDA formed a work group in early 1996. The work group reviewed the past sampling information, and devised a sampling plan that was more structured than previous MDA sampling regimes. The plan included soil sample analysis for two classes of pesticides, base neutral pesticides and sulfonylurea pesticides. These classes included several pesticides that have been registered since 1989. (Several other commonly used pesticide classes, such as imidazolinone herbicides, were not included in the analysis. See the Methods section, Analysis of Pesticides, for more information.)

Using 1989 as the baseline year and pesticides registered since that time, the 1996 sampling plan was designed to provide a "before and after" comparison, to show if pesticide contamination was still occurring at Minnesota crop production retailer facilities. To increase the likelihood of obtaining meaningful data, the MDA work group evaluated recently registered products which had been used in significant quantities in the state of Minnesota. The products meeting that criteria included thifensulfuron-methyl, registered in 1989; nicosulfuron, registered in 1990; and acetochlor, registered in 1994. For this project, the products would serve only as a time indicator for determining recent contamination. Since handling practices and safeguard construction had improved since 1989, detects of any products registered since then could indicate if facility contamination was recent or historical.

Not only was the soil sampling in 1996 conducted to assess the success of the improved facility practices and the recently constructed storage facilities, but also to informally assess the handling practices of individual retailers. The work group stressed that if sampling results indicated that ongoing contamination was a widespread concern, then the outcome and focus of the sampling should be to discover solutions that might successfully prevent future contamination, and to communicate these solutions to the crop production retailers. In order to discover the possible reasons for contamination and the realistic solutions for prevention, the work group interviewed retailer facility managers to get practical answers from those closest to the situation. This report, written for crop production retailers, is the initial vehicle for communicating the results of the 1996 soil sampling program.

Materials and Methods

Analysis of Pesticides. Only pesticides, and no fertilizers, were analyzed for the soil samples collected for the 1996 soil sampling program. Two groups of pesticides were selected for analysis of the soil samples: base neutral pesticides (designated as MDA List 1) and sulfonylurea pesticides. Table 1 lists the pesticide common name, a trade name, and the year of registration for use in Minnesota.

Table 1. Pesticide analysis for soil sampling in 1996.

Base Neutral Pesticides	Year Reg.*
Acetochlor (Harness, Surpass)	1994
Alachlor (Lasso)	Pre-1989
Atrazine	Pre-1989
Desethylatrazine	Pre-1989
Desisopropylatrazine	Pre-1989
Chlorpyrifos (Dursban)	Pre-1989
Cyanazine (Bladex)	Pre-1989
EPTC (Eradicane)	Pre-1989
Ethalfluralin (Sonolan)	Pre-1989
Fonofos (Dyfonate)	Pre-1989
Metolachlor (Dual)	Pre-1989
Metribuzin (Sencor, Lexone)	Pre-1989
Pendamethalin (Prowl)	Pre-1989
Phorate (Thimet)	Pre-1989
Prometon (Pramitol)	Pre-1989
Propachlor (Ramrod)	Pre-1989
Propazine (Prozenex)	Pre-1989
Simazine (Princep)	Pre-1989
Terbufos (Counter)	Pre-1989
Triallate (Far-Go)	Pre-1989
Trifluralin (Treflan)	Pre-1989
Sulfonylurea Pesticides	**Year Reg.***
Chlorimuron-ethyl (Classic)	Pre-1989
Chlorsulfuron (Glean)	Pre-1989
Metsulfuron-methyl (Escort)	Pre-1989
Nicosulfuron (Accent)	1990
Primsulfuron-methyl (Beacon)	1990
Sulfometuron-methyl (Oust)	Pre-1989
Thifensulfuron-methyl (Pinnacle)	1989
Triasulfuron (Amber)	1992
Tribenuron-methyl (Express)	1989

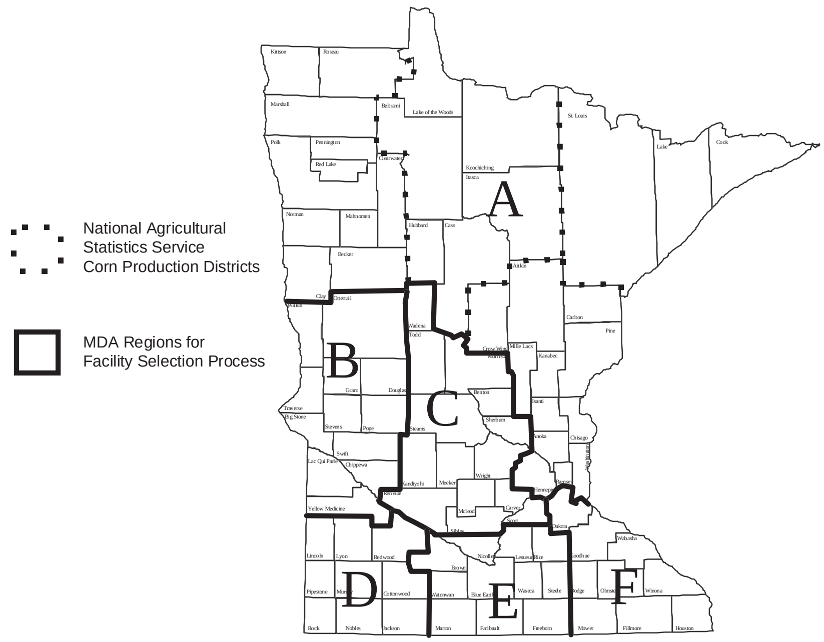
* For use in Minnesota.

Several pesticides commonly used in Minnesota were not included for various reasons. The imidazolinone herbicides, which include Pursuit (imazethapyr), were not analyzed because MDA Laboratory Services Division did not have a validated method for analysis at the time of sampling in 1996. The acid herbicides, such as 2,4-D, have not been major concerns on most agricultural chemical retailer facilities, most likely due to the relatively short half-lives of these compounds. Roundup (glyphosate) and Basagran (bentazon), two commonly used products in Minnesota, have not been commonly detected in historical soil sample analysis through regular laboratory methods used by MDA Laboratory Services, and other laboratories. For more detailed information about laboratory methods, please contact Gareth Horvath, MDA Laboratory Services, at (612) 296-1535.

Facility selection criteria. The National Agricultural Statistics Service reporting districts for corn production (see Figure 1) were used to create six regions for the facility selection process. All licensed restricted use pesticide (RUP) retailers for each county were placed by location into the appropriate region, and each RUP retailer was assigned a consecutive number within their region. A list of ten randomly selected RUP retailers from each region was generated using their assigned numbers. Each selected RUP retailer was assigned a code to assure anonymity when analyzing and reporting the study results.

Each facility was categorized as a large, medium or small facility, based on the estimated amount of pesticide product handled. This estimate was derived from MDA facility files, inspections and 1994/1995 RUP sales records. MDA information was used only as a general indication of the amount of product handled by a facility. This was deemed sufficiently accurate for the purposes of the sampling plan.

Figure 1: Facility Selection Regions



Following the order in which the retailers were randomly selected, the work group selected two large facilities, two medium facilities and one small facility for sampling in each region. This resulted in a total of 30 facilities to be sampled. In several cases, the region did not have two large retailer facilities, and therefore an additional medium retailer facility was selected to total five facilities within each region. Subsequent observations gathered during sampling further defined the final size designation. This resulted in the selection of 7 large facilities, 13 medium facilities and 10 small facilities chosen from across all six regions (A-F).

Controlled sampling plan implementation. The controlled sampling plan was implemented in the last two weeks of August and the first week in September of 1996. The short time frame was selected to reduce the temporal variability in sampling. The time frame was also selected to minimize disruption of facility activities during the spring high-volume business season.

Soil sampling was conducted in areas which are generally regarded to be at high risk for contamination at agricultural chemical facilities, because of the amount of pesticides handled in these areas. The five areas include:

1. small package pesticide mix and load areas;
2. bulk pesticide load out areas;
3. fertilizer impregnation tower areas;
4. water fill areas, and
5. runoff areas and areas with dead or stressed vegetation.

The overall objective was to sample only the above five areas, if found on the facility. Actually, more or less than five samples could be collected at each facility. For example, small facilities do not store bulk pesticides on the site, and larger facilities often combine operations, such as loading small package pesticides on the bulk pesticide load pad. In these cases, less than five samples would have been collected at the facility. Alternatively, some facilities had individual high risk locations encompassing a large area, where more than one soil sample may have been collected at each target location to adequately address the entire area. In these cases, more than five samples would have been collected.

Sample collection procedures. A composite surficial soil sample was collected at each available designated soil sampling location on each facility. The composite samples consisted of four subsamples of equal volume, collected at 0 to 6 inch depth, and over an area no larger than 15 feet in diameter. The subsamples were mixed thoroughly to create one sample for analysis. MDA commonly and effectively uses compositing of subsamples to broadly characterize a large area or volume of soil.

Hand augers, pick axes, shovels and other tools were used to collect the soil samples. New pairs of disposable nitrile gloves were used at each sampling location to prevent cross contamination of samples. All non-disposable equipment that came into direct contact with the sample was replaced or cleaned, following MDA protocol, between each sample. Photographs of the disturbed soil at each composite sampling location were taken after the samples were collected. The photographs were marked with the sampling date, photographer's name, sample number and sample location. To ensure the integrity of the samples, a chain of custody procedure was used, and all samples were sealed in accordance with the EPA/FIFRA official "inverted bag" procedure.

MDA personnel were obligated to document any observed incident or bulk storage related compliance issues, but due to time constraints, a full pesticide facility inspection was not conducted and other types of compliance monitoring activities, such as record checks, applicator licensing, etc. were not performed.

Results

Presentation of results. Agricultural chemical retail facilities are located in a variety of environmental settings. When the soil on a retail facility is documented with pesticide contamination, the level of contamination in the sample, along with environmental factors such as type of soil, depth to ground water, distance to residential wells, etc., are considered by MDA staff when deciding if further investigation is needed at the facility, and also what the "cleanup goal" will be for that particular facility. A cleanup goal is the level of contaminant in the soil or water that the corrective (or cleanup) actions must achieve before no further action is required at the facility. When facilities perform cleanups, all final cleanup goals for each facility are site-specific and dependent on the unique characteristics of each facility site.

The MDA Incident Response Unit has established "generic" preliminary soil cleanup goals for many pesticides commonly found on retailer facilities. Exposure to human health, leaching of contaminants to ground water, and label application rates were considered in the development of these generic soil cleanup goals, which constitute a starting point for each site's final cleanup goals. The soil cleanup goals based on leaching to ground water also considered scenarios of high, moderate and low risk to ground water. Please see the MDA guidance document entitled "MDA Soil Cleanup Goals" in Appendix 2 for more information on generic cleanup goals.

In order to eliminate the variables involved with each facility's environmental setting, the data is presented initially in comparison with the generic cleanup goal for moderate risk to ground water. For sulfonylurea herbicides, the generic cleanup goals were based only on the label rate for the particular sulfonylurea product. Therefore, throughout this report, when levels or contamination are considered significant or of concern in the sample, this refers to pesticide levels that are above the generic cleanup goal.

Pesticide detections in the samples. Table 2 lists all pesticides for which each sample was analyzed, and the laboratory method detection limit. Desethylatrazine and desisopropylatrazine are metabolites, or breakdown products, of atrazine. The base neutral list is also known as MDA List 1, which is commonly used for investigation of historical incidents on retailer facilities. Again, the analytical parameters consisted of only the pesticide groups of base

Table 2. Pesticide common names and trade names for which soil samples were analyzed, and their corresponding method detection limits (MDL).

Base Neutral Pesticides	MDL
Acetochlor (Harness, Surpass)	0.1 ppm*
Alachlor (Lasso)	0.1 ppm
Atrazine	0.1 ppm
Desethylatrazine	0.1 ppm
Desisopropylatrazine	0.1 ppm
Chlorpyrifos (Dursban)	0.1 ppm
Cyanazine (Bladex)	0.1 ppm
EPTC (Eradicane)	0.1 ppm
Ethalfluralin (Sonolan)	0.1 ppm
Fonofos (Dyfonate)	0.1 ppm
Metolachlor (Dual)	0.1 ppm
Metribuzin (Sencor, Lexone)	0.1 ppm
Pendamethalin (Prowl)	0.1 ppm
Phorate (Thimet)	0.1 ppm
Prometon (Pramitol)	0.1 ppm
Propachlor (Ramrod)	0.1 ppm
Propazine (Prozenex)	0.1 ppm
Simazine (Princep)	0.1 ppm
Terbufos (Counter)	0.1 ppm
Triallate (Far-Go)	0.1 ppm
Trifluralin (Treflan)	0.1 ppm
Sulfonylurea Pesticides	**MDL**
Chlorimuron-ethyl (Classic)	0.001 ppm
Chlorsulfuron (Glean)	0.001 ppm
Metsulfuron-methyl (Escort)	0.001 ppm
Nicosulfuron (Accent)	0.001 ppm
Primsulfuron-methyl (Beacon)	0.001 ppm
Sulfometuron-methyl (Oust)	0.001 ppm
Thifensulfuron-methyl (Pinnacle)	0.001 ppm
Triasulfuron (Amber)	0.001 ppm
Tribenuron-methyl (Express)	0.001 ppm

* ppm = parts per million or mg/kg.

neutrals and sulfonylureas. Imidazolinones, and other commonly used pesticides, and fertilizers were not tested. The pesticides in Table 2 that were registered for use in Minnesota after 1989 and were detected in the 1996 soil sampling are acetochlor, nicosulfuron and thifensulfuron-methyl.

A total of 93 soil samples were collected from the thirty different facilities. Some level of pesticides were detected in 84 of the samples. A number of different pesticides were detected, and the ten pesticides most commonly detected at any level are listed in Table 3. Table 3 also shows the number of detections in the soil samples, the range of pesticide concentrations detected and the average value detected. These are pesticides which were detected above MDA laboratory's minimum detection limit, and do not necessarily indicate that facility clean up is needed.

Table 3. Ten pesticides most commonly detected out of 93 total samples.

Pesticide Common Name	Number of Detections	Range of Concentrations Detected (ppm)	Average of Values Detected (ppm)
Metolachlor	66	< 0.1 - 428	7.93
Pendimethalin	57	< 0.1 - 38.6	1.54
Acetochlor	55	< 0.1 - 81.6	1.84
Alachlor	55	< 0.1 - 91	3.27
Trifluralin	51	< 0.1 - 81.9	3.67
Atrazine	38	< 0.1 - 20.5	0.49
Nicosulfuron	36	< 0.001 - 0.071	0.005
EPTC	21	< 0.1 - 1.8	0.09
Prometon	20	< 0.11 - 0.59	0.05
Triallate	14	< 0.1 - 369	4.08

*Average values were calculated assuming a non-detect was equal to zero, thus some averages appear lower than the range of concentrations detected.

Table 4 lists the ten pesticides that exceeded the generic cleanup goal, as determined by MDA's Incident Response Unit (see Appendix 2 for information on MDA soil cleanup goals). As previously mentioned, for the purposes of this summary and the sake of comparison, MDA's generic cleanup goal was used as the indicator of a significant level of contamination.

Sulfonylureas are generally used and are effective at ultra-low levels. The cleanup goals, and all detection levels, for nicosulfuron and thifensulfuron-methyl (both sulfonylurea herbicides) are given in parts per million in this report, for ease of comparison. Prometon, which is labeled for weed control use on facilities, was not found above the clean-up goal at any facility sampled.

Pesticides registered in 1989 and later. To test if new contamination was occurring, the number of samples with pesticides registered in 1989 and later was calculated. In 93 total samples, 64 samples contained pesticides registered since 1989. This would indicate that contamination has occurred more recently than 1989 in 68 percent of the samples. Of the 64 samples with detections,

Table 4. Number of samples per pesticide, out of 93 total, that exceeded a generic cleanup goal.

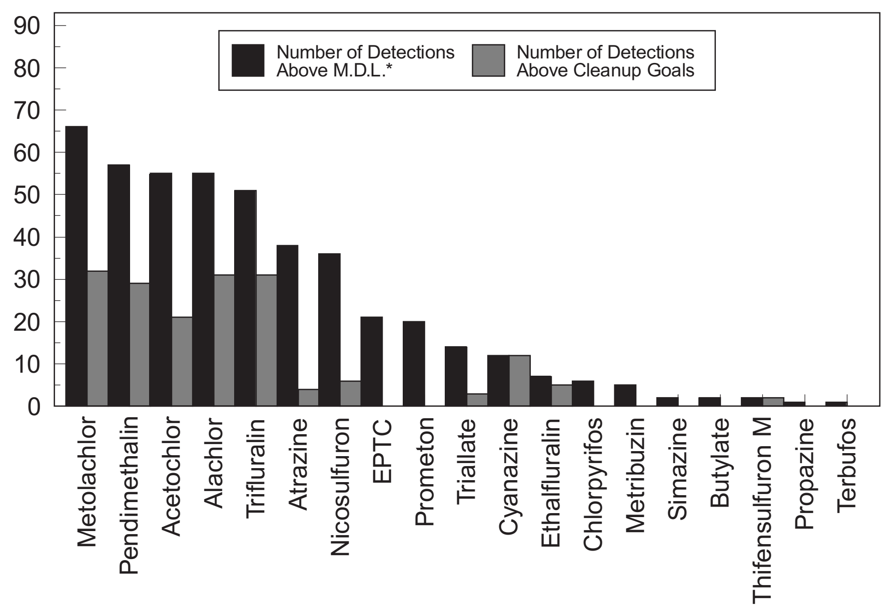
Pesticide Name	Generic Cleanup Goal	Number of Samples Exceeding Cleanup Goal
Metolachlor	1.50 ppm	32
Alachlor	0.50 ppm	31
Trifluralin	0.50 ppm	31
Pendimethalin	0.75 ppm	29
Acetochlor	1.00 ppm	21
Cyanazine	0.20 ppm	12
Nicosulfuron	0.03 ppm	6
Ethalfluralin	0.50 ppm	5
Atrazine	2.00 ppm	4
Triallate	1.00 ppm	3
Thifensulfuron-methyl	0.004 ppm	2

25 samples (39 percent) contained post-1989 registered pesticides above the generic cleanup goal.

Figure 2 compares the number of detections to the number of detections exceeding the generic cleanup goal. For pesticides registered since 1989, acetochlor levels were of concern in about 38 percent of the acetochlor detections. Nicosulfuron levels were of concern in about 16 percent of the nicosulfuron detections. Thifensulfuron-methyl levels were of concern in both instances of detection.

Pesticides registered before 1989. In most cases of the pesticides registered before 1989, the concentrations were of concern in about half of the samples with detections. Half of the total samples contained positive detections of pesticides registered before 1989. This was especially true for metolachlor, pendimethalin, alachlor and trifluralin. This pattern is consistent with and cannot be separated from historical, or pre-1989, contamination that appears frequently on retailer facilities. The exception may be atrazine, which was of concern in only 10 percent of the samples in which it was detected. Atrazine has been a significant contaminant on facilities in the past. Some possibilities for lower detections include degradation in the upper six inches, less usage in some areas of the state in recent years, or leaching of atrazine below the six inch depth that MDA sampled.

Figure 2. Pesticide Detections



* Method Detection Limit

Of the 30 retailer facilities sampled, at least one of the recently registered pesticides was found on 23 of the facilities. On 10 of those facilities, the concentrations of these newer pesticides were above the generic cleanup goals. It appears that facility contamination of pesticides registered since 1989 may be more notable than previously realized. This may indicate that, even with generally improved practices and new bulk containment, some product continues to escape into soils on retailer facilities, and in some cases at a significant level.

Sample areas on the facilities. As stated previously, five areas were targeted for sampling at each facility. However, it was expected that each facility could have more or less samples taken, based on the situation. At the large facilities, an average of 3.9 samples were collected per facility. At the medium facilities, an average of 3.5 samples were collected. At the small facilities, the collected samples averaged at 2.1. Table 5 summarizes the data from the sampling, and compares the total number of detections with the number of samples where recently registered pesticides were detected.

Pesticides were detected at each of the five high risk areas targeted for investigation. The area at highest risk for more recent and significant contamination appears to be the bulk pesticide storage area. This is probably because of the greater amount of pesticide handled in this area. The bulk pesticide storage area is followed by the fertilizer impregnation area, the small package mix and load area, the water fill area and the runoff areas. This also appears to correlate well with the amount of product handled in each area.

Table 5. Sampling results by location on facility.

Location	Bulk Pesticide Mix and Load	Fertilizer Impregnation	Small Package Mix and Load	Water Fill Station	Runoff Areas
No. samples	27	24	26	12	4
No. samples with pesticide detection	25	23	21	11	4
No. samples with pesticide detection above cleanup goal	20	16	13	10	3
No. samples with post-1989 registered pesticide detection	22	18	12	9	3
No. samples with post-1989 registered pesticide detection above cleanup goal	10	10	1	4	0

Facility size and contamination. Of the 30 facilities sampled, 28 showed a detectable level of pesticides in at least one sample. Two facilities had no detections. These two facilities were categorized as small facilities, and one sample was collected from each. Based on sales records and observations of the facilities, both of which specialized in feed products, the minimal amount of pesticides sold probably explained the lack of contamination.

Of the large facilities, all seven facilities had at least one sample with a detection above the cleanup goal. Ten of the thirteen medium facilities, and eight of the ten small facilities, had at least one sample above the cleanup goal. Of thirty facilities, five (three medium, two small) facilities did not register any detections above the cleanup goal.

These five facilities were reviewed in regard to their environmental setting and potential risks associated with contamination, to ascertain the suitability of the generic cleanup goals on these sites. Based on the review, MDA determined that the generic cleanup goals were appropriate, and therefore no further investigation or cleanup would be requested at these facilities, based on this sampling. Please note that surficial soil sampling in selected areas, such as conducted in this program, does not represent a complete facility investigation. The sampling was used as an indicator only.

Three additional medium facilities and two additional small facilities had pesticide detections that were marginally above the cleanup goal. A review of the same factors listed above, along with the generic cleanup goals, resulted in an MDA determination that these facilities also would not require further action, based on the sample results.

Finally, the remaining facilities were put through a prioritization process whereby data is collected on the surrounding environment of each facility. The facility is ranked, based on a numerical score and other information drawn from environmental and risk indicators, as to its possible impact on the environment and public health. This process is similar to the U.S. Environmental Protection Agency's Hazard Ranking Preliminary Assessment Scoresheet (used for screening sites on the national Superfund list). After this process, MDA determined that one large facility and three additional medium facilities would not require further action, based on the 1996 sampling results.

Therefore, after evaluating each facility based on the sample pesticide levels and the environmental and risk setting, MDA determined that no further work was needed at one of the seven large facilities (14 percent), nine of the thirteen medium facilities (69 percent), and six of the ten small facilities (60 percent). The remaining facilities that will need further investigation were added to the MDA Incident Response Unit priority list, or entered the MDA voluntary cleanup program. For additional information about the priority list or the ranking process, please contact Michele Puchalski, MDA Incident Response Unit, at (612) 297-7283.

A table of all analytical results by encoded facility and sample location are contained in Appendix 1.

Telephone Interviews with Facility Managers

Telephone interviews. Once MDA Laboratory Services reported the sample results, the work group conducted informal phone interviews with a majority of the facility managers regarding their facility practices. The work group attempted to contact all the facility managers that were included in the program before mailing the analyses results to them, to explain the meaning of the reports of analysis. Selection of interviewees was subjectively based on the results of the sampling, size of the facility, and willingness of the facility manager to discuss the results.

Of special interest to MDA were the apparently successful management practices at facilities with low or no levels of contamination, and also the possible reasons for contamination at facilities with higher or significant levels of contamination. (Significance of contamination levels is based on MDA's generic cleanup goals. See MDA guidance document entitled "MDA Soil Cleanup Goals" in Appendix 2 for more information on generic cleanup goals.) Managers in both situations were extremely helpful and cooperative, and provided valuable insights into what works effectively—and also what challenges exist—when operating a pesticide retail business and attempting to prevent facility contamination.

The interviews made very apparent that every facility's circumstance was unique in some way, each presenting different challenges with different possible solutions. These types of scenarios are difficult to regulate with specific requirements, because the same solution will not fit every circumstance. While the current regulations for bulk pesticide storage are an excellent safeguard baseline, general housekeeping and possible site-specific capital improvements are essential in order to successfully prevent contamination, and each retailer must evaluate their own situation to evaluate waste reduction, product cleanup, and other pollution prevention opportunities.

The following is a synopsis of the information gained from these conversations with retailer facility managers. This information should help raise awareness of where safeguards can be deficient, and in some instances solutions are offered to mitigate these deficiencies. Further discussion is needed among the retailers, the ag chemical industry and the MDA to create and communicate additional solutions.

Small package mix and load area. Historically (before 1989), the area adjacent to the small package storage was routinely used for mixing and loading pesticides. All facility managers interviewed indicated that currently most small package products are loaded in the field, or on bulk pesticide storage pads. Product is also commonly sold to growers in unopened packages from this location on the facility.

In this area, there was no significant difference in facility handling practices between those retailers with little contamination or significant contamination. Although newer products were occasionally found in these areas, it appeared that almost all significant detects were from older products, perhaps indicating that most contamination is a result of historical use. However, some of the highest values were found in this area, and one possibility may be the occurrence of previous spills not properly managed.

Bulk pesticide mix and load area. At facilities with little or no contamination, the managers indicated that the pad was swept on a regular basis, usually daily but sometimes weekly. Proper management of these sweepings was enforced by facility management, and also made as convenient as possible for personnel. For example, a clean, empty barrel or some similar container was always present on the bulk load pad, specifically for the placement of sweepings. The collected sweepings were then put into the next load of dry fertilizer going out to the appropriate field. Collected sweepings were not allowed to accumulate over time into large quantities. All

spills, including very small ones, were cleaned up immediately by covering with absorbent, and then were managed the same as the sweepings.
The use of these housekeeping practices appeared to be significantly linked to facilities with lower contaminant levels. Such cleaning can be facilitated by checksheets and/or work orders for employees to complete. These reports can serve as a record of such activities.

Managers mentioned washing the pads at only two facilities. This is rarely done because of the difficulty in managing the rinsate, which must be tested before spreading to determine if the rinsate should be spread on corn or soybean fields. Some retailers' roofed bulk storage buildings collected rain during storms, because the open garage door faced prevailing winds, thus inadvertently washing the pad. This problem is best addressed in the original design phase of the facility.

Equipment tires tracking over pad floors and picking up contamination appeared to be the most logical explanation to the facility managers for pesticide detections outside of bulk storage buildings. The contamination on the pad floor may be a result of infrequent and/or improper cleanup of large or small spills, and also from soil on spray rigs falling onto the floor. Facilities mentioned that the tire tracking problem may be magnified by wet pads, caused by 28% liquid fertilizer on the pad collecting moisture from humid air. Alternatively, precipitation may also dampen the pad floor, depending on the directional setting of the building.

Other possible causes for contamination mentioned by managers are improper management of sweepings, washing equipment outside the bulk storage building, and leaking nozzles on growers' equipment.

Fertilizer impregnation area. Managers at facilities with little or no contamination in the soil samples indicated that they sweep the pad once or more daily. The sweepings were also strictly managed, with a barrel or some other container available for collection. The sweepings were included with the next dry load of fertilizer.

Several facility managers with low levels of contamination in this area indicated they regularly used a downspout from the tower or conveyor to reduce wind drifting of the fertilizer. However, one facility manager with higher levels in this area had trouble with the downspout clogging if placed too close to the truck. Accordingly, they placed the downspout about two feet away from the top of the trucks, thus reducing its effectiveness.

One facility conveyor was completely enclosed within a building, and no significant contamination was found near this area of the facility. Another facility with low levels near this area used trucks with closed boxes which were well matched with the height of the fertilizer loadout.

Managers with significant facility contamination expressed concern about the slope of and water runoff across their pads. These pads were swept, but not daily. The managers also admitted that proper management of sweepings might not always be closely monitored, and it was possible that the sweepings from the pad went onto the ground instead of into a container.

Water fill station. Many facilities with little contamination did not allow growers to fill their equipment, or fill their equipment unattended in this area. The few facilities with little or no contamination that did allow growers to fill usually had strict control over who was filling, such as water controls inside a building. Alternatively, they could easily view all water filling from some attended vantage point. One facility with lower levels of contamination stated that only growers who bought product were allowed to fill, and it was made clear to them they could fill only water tanks, not tanks used for product.

Most managers generally recognized the risk in allowing growers to fill from a water station, but in some cases the managers felt the customers in their area expected this service. All facility managers interviewed indicated that growers were told to fill only water tanks, and not tanks used for product, but follow through of this policy appeared to vary widely in success.

Runoff areas. Few runoff areas were observed for sampling. Contaminant levels in these areas were fairly low, although often high enough to kill the vegetation that might grow there. Affected runoff areas can be an indication of a more seriously impacted area on the facility, and are probably best addressed by implementing better management practices at the source areas.

Conclusion

Since the passage of the 1989 Ground Water Protection Act in Minnesota, awareness of pesticide contamination on retail facilities by facility personnel has increased dramatically. Changes in practices and installation of required safeguards appear to have reduced the likelihood of further contamination of facility grounds. However, the 1996 MDA soil sampling indicates that in as little as three years, contamination is reappearing at significant levels on many retailer facilities. Soil sampling has indicated that better management is needed at many facilities. The interviews with retailers appear to support the conclusion that better management works. The new concrete containment of the bulk storage safeguards have been very effective at preventing many incidents, but alone, they are not a panacea. In order to avoid contamination it is important to recognize that better management practices—housekeeping and sometimes extra capital improvements—still play an integral part in keeping a crop production retail facility free of contamination.

While the MDA can effectively regulate and remediate a contaminant release once it has occurred, it would be beneficial for the crop production retailer to prevent the release from occurring in the first place, as time and costs for investigation and cleanup are substantial. Additional benefits of avoiding contamination include less regulatory oversight, averted liability for off-site health or environmental affects, and less shrinkage costs from lost product.

The MDA bulk pesticide storage rules are an excellent baseline regulation, helping to level the playing field for competition and preventing contamination from large releases. However, each retailer facility is unique in its location and business practices. Because not every solution will fit every circumstance, additional regulation is difficult to create. A better solution is to develop contamination prevention techniques which each retailer can evaluate and, if appropriate, implement on the facility.

Communication of specific contamination prevention techniques will take a concerted effort from all corners of the agricultural chemical industry. MDA hopes to work with the industry representatives to facilitate the discussion of these opportunities, but recognizes that the most proficient outreach will originate from trade associations, pesticide registrants, and crop production retailers themselves.

Appendix 1

Complete Facility Sample Results

Facility	Location	Acetochlor	Alachlor	Atrazine	Chlorpyrifos	Cyanazine	EPTC	Ethalfluralin	Metolachlor	Metribuzin	Pendimethalin	Prometon	Propachlor	Propazine	Simazine	Triallate	Trifluralin	Butylate	Terbufos	Nicosulfuron	Thifensulfuran-m
A11	Bulk Pesticide load	1.3	0.9	0.6	0	0	0	0	0.8	0	0	0	0	0	0	0	0	0	0	0	0
A11	Fert impregnation	1.2	0.7	0.8	0	0	0	0	0.7	0	0.4	0	0	0	0	0	0	0	0	0.0034	0
A11	Fert impregnation	0.5	0.2	20.5	0	0	0.1	0	2.1	0	0	0	0	0	0	0	0	0	0	0.0056	0
A11	Runoff area	0	0.5	0.1	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0
A14	Bulk Pesticide load	0	0.29	0	0	0	0	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0
A14	Bulk Pesticide load	0	0	0	0	0	0	0	0.3	0	0	0.3	0	0	0	0	0	0	0	0	0
A14	Small pkg mix/load	0.1	0	0.3	0	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0
A14	Small pkg mix/load	0	0	5.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A14	Small pkg mix/load	0	0	0.3	0	0	0	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0
A14	Small pkg mix/load	0	0.2	0.3	0	0	0	0	0.4	0	0.2	0	0	0	0	0	0	0	0	0	0
A16	Small pkg mix/load	0	0	0.3	0	0.7	0	0.6	0.4	0	0.2	0	0	0	0	0.6	1.6	0	0	0.0032	0
A16	Water fill	0.3	0	0.5	0	0	0.5	369	6.5	0	0.8	0.2	0	0	0	0	5.4	0	0	0.0717	0.112
A24	Bulk Pesticide load	0.6	1.6	0.1	0	0	0	1.7	0	0	0.2	0	0	0	0	0.3	0.5	0	0	0.0016	0
A24	Small pkg mix/load	0	1.3	0.1	0	0	0.2	0	1.7	0	0	0	0	0	0	369	24.5	0	0	0	0
A24	Water fill	0	53.1	0.1	0	0.3	0.3	0	0	0	0	0	0	0	0	5.5	1.8	0	0	0.0017	0
A131	Bulk Pesticide load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A131	Small pkg mix/load	0	0.1	1.6	0	0	0	0	0.4	0	0.8	0	0	0.1	0	0	0	0	0	0.0011	0
A131	Small pkg mix/load	0	0	0.1	0	0	0	0	0.2	0	0	0.2	0	0	0	0	0	0	0	0	0
B11	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B11	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0.1	1.7	0	0	0.0011	0
B12	Bulk Pesticide load	1.97	0	0	0	0	0	0	0.31	0	0.32	0	0	0	0	1.29	0.87	0	0	0	0
B12	Fert impregnation	1	0.15	0	0	1.14	0	0.24	0.5	0	0.43	0	0	0	0	0.23	1.17	0	0	0	0
B31	Bulk Pesticide load	81.6	1	0	0	0	0	0	0.4	0	4.6	0	0	0	0	0	25.3	0	0	0.0654	0
B31	Fert impregnation	9.3	2.3	0	0	0	1.4	0	2.6	0	0.4	0	0	0	0	0	0.5	0	0	0	0
B31	Fert impregnation	3.6	61.9	0	0	0	1.8	0	11.2	0	7.6	0	0	0	0	0	1.3	0	0	0	0
B31	Small pkg mix/load	0.3	0.6	0	0	0	0	0	0.8	0	0.3	0	0	0	0	0.2	0.2	0	0	0.018	0
B39	Fert impregnation	0	1.6	0	0	0	0	0.2	0	0	0	0	0	0	0	0.12	0.28	0	0	0	0
B39	Fert impregnation	0.24	0.3	0	0.57	0	0.1	5.5	0	0	0	0	0	0	0	0.56	7.5	0.53	0	0	0
B39	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.9	0	0	0.0035	0
B39	Water fill	0.26	0.32	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0.78	0	0	0.0218	0
B104	Bulk Pesticide load	0.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0
B104	Small pkg mix/load	0	0	0.11	0	2.2	0.1	0	0	0	0	0.12	0	0	0	0.42	0	0	0	0	0
B104	Water fill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.34	1.1	0	0	0	0
C13	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C31	Fert impregnation	2.5	1.5	0.5	0	0	0	0	3.3	0	3.6	0.2	0	0	0	0	0.2	0	0	0.0043	0

All parameters are given in parts per million.

*In this table, if a compound was not detected at or above the method detection limit, a zero (0) was entered into the table. See Table 2, page 9 for method detection limits.

Facility	Location	Acetochlor	Alachlor	Atrazine	Chlorpyrifos	Cyanazine	EPTC	Ethalfluralin	Metolachlor	Metribuzin	Pendimethalin	Prometon	Propachlor	Propazine	Simazine	Triallate	Trifluralin	Butylate	Terbufos	Nicosulfuron	Thifensulfuran-m
C31	Fert impregnation	4.6	2.4	0	0	0	0	0	2.2	0	2.4	0.3	0	0	0.4	0	17.4	0	0	0	0
C31	Small pkg mix/load	1.4	2	2.7	0	0	0	0	1.6	0	38.6	0.2	0	0	0	0	1.1	0	0	0.0034	0
C39	Bulk Pesticide load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C39	Bulk Pesticide load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14	0	0	0	0	0
C43	Bulk Pesticide load	0.19	0	0	0	0	0	0	0.99	0	3.3	0	0	0	0	0	0	0	0	0.0184	0
C43	Bulk Pesticide load	0	0.13	0.13	0	1.6	0	0	2	0	2.1	0	0	0	0	0	0	0	0	0.029	0
C43	Fert impregnation	0.78	0.12	0	0	0	0	0	0.53	0	0.11	0	0	0	0	0	0	0	0	0.0027	0
C43	Fert impregnation	0.75	0.11	0	0	0	0.1	0	0.98	0	1.3	0	0	0	0	0	0	0	0	0.0027	0
C88	Bulk Pesticide load	0.25	0.19	0.12	0	0.31	0	0	1.2	0	0.38	0	0	0	0	0	0	0	0	0.0061	0
C88	Fert Impregnation	0	0	0	0	0	0	0	0.66	0	0	0	0	0	0	0	0	0	0	0	0
C88	Fert Impregnation	0.11	0	0	0.7	0	0	0	0.53	0	0.22	0	0	0	0	0	0	0	0	0	0
D9	Bulk Pesticide load	0	0.1	0	0	0	0	0	2.47	0	0.18	0	0	0	0	0	2.22	0	0	0.0014	0
D9	Fert impregnation	0.21	0	0	0	0	0	0	7.22	0	0.18	0	0	0	0	0	0.44	0	0	0	0
D9	Small pkg mix/load	0.95	0	0.17	0	0	0	0	3.34	0	0.28	0	0	0	0	0	0.19	0	0	0.0084	0
D23	Bulk Pesticide load	1.43	0.91	0	0	0	0	0	0.18	0	0.85	0	0	0	0	0	0.48	0	0	0.0045	0
D23	Bulk Pesticide load	2.09	0.48	0	0	0	0	0	0.48	0	0.74	0	0	0	0	0	1.38	0	0	0.0121	0
D23	Fert impregnation	0	0.1	0	0	0	0	0	0.12	0	0.37	0	0	0	0	0	2.06	0	0	0	0
D23	Small pkg mix/load	0.46	0	0	0	0	0	0	0.1	0	0.16	0	0	0	0	0	0.13	0	0	0	0
D23	Water fill	0.68	1.02	1.13	0	0	0	0	27.5	0.13	1.94	0.13	0	0	0	0	19.4	0.47	0	0.063	0
D28	Small pkg mix/load	0	0	0.42	0	0	0	0	0	0	0	0.18	0	0	0	0	0	0	0	0	0
D69	Bulk Pesticide load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0015	0
D69	Fert impregnation	0.34	0	0	0	0	0	0	0.4	0	0	0.11	0	0	0	0	0	0	0	0	0
D69	Runoff area	0	0	0	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0.0017	0
D69	Water fill	0.76	0	0	0	0.24	0	0	0.33	0	0.22	0.13	0	0	0	0	3.8	0	0	0.0033	0
D80	Bulk Pesticide load	0.65	0.24	0.78	0	0.62	0.1	0	5.06	0.13	1.78	0	0	0	0	0	0.71	0	0	0.0093	0
D80	Bulk Pesticide load	0.7	0.12	1.59	0	0	0.2	0	2.16	0.13	1.59	0	0	0	0	0	0.2	0	0	0.0048	0.012
D80	Fert impregnation	9.06	3.09	0	0	0	0.3	0	25.6	0	0.32	0	0	0	0	0	0.3	0	0	0	0
D80	Small pkg mix/load	0.41	0	2	0	0	0	0	428	0	0.25	0	0	0	0	0	0.14	0	0.13	0	0
E10	Bulk Pesticide load	0.43	0.2	0	0	0	0	0	2.03	0	0	0	0	0	0	0	0.25	0	0	0	0
E10	Bulk Pesticide load	0.3	0.63	0	0	0	0	0	4.55	0	0.28	0	0	0	0	0	0.3	0	0	0	0
E10	Small pkg mix/load	0	0	0	0	0	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0
E10	Water fill	0.38	0.42	0.19	0	0	0	0	2.68	0	0.54	0.12	0	0	0	0	1.76	0	0	0	0
E33	Fert impregnation	0.26	0.14	0	0	0	0	0	0.51	0	0.31	0	0	0	0	0	0.21	0	0	0	0
E33	Small pkg mix/load	0.12	0.26	0	0.18	0	0	0	0.19	0	1.38	0	0	0	0	0	0.19	0	0	0	0
E33	Water fill	0.14	0.21	0	0	0	0	0	0.16	0.16	0.21	0	0	0	0	0	0	0	0	0.0047	0

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Facility	Location	Acetochlor	Alachlor	Atrazine	Chlorpyrifos	Cyanazine	EPTC	Ethalfluralin	Metolachlor	Metribuzin	Pendimethalin	Prometon	Propachlor	Propazine	Simazine	Triallate	Trifluralin	Butylate	Terbufos	Nicosulfuron	Thifensulfuran-m
E36	Fert impregnation	0	0.1	0	0	0	0	0	1.04	0	0.3	0	0	0	0	0	0.48	0	0	0	0
E36	Water fill	0	2.45	0.23	0	0	0.2	0	20.62	0	0.39	0.26	0	0	0	0	11.62	0	0	0	0
E37	Bulk Pesticide load	9.94	0.52	0.25	0	0	0.1	0	8.69	0	1.2	0.15	0	0	0	0	81.9	0	0	0	0
E37	Bulk Pesticide load	7.66	0.73	0.62	0	0	0.1	0	7.12	0	3.97	0.47	0	0	0	0	71.9	0	0	0.0033	0
E37	Fert impregnation	1.04	2.42	0	0	0	0.5	0	45	0.26	1.77	0	0	0	0	0	2.43	0	0	0	0
E37	Fert impregnation	1.8	3.72	0	0	0	1.5	0	28.75	0	1.4	0	0	0	0	0	0.54	0	0	0.0331	0
E37	Water fill	1.74	52.5	0	0.17	0	0.1	0	36.9	0	32.2	0	0	0	0	0	34.1	0	0	0	0
E89	Bulk Pesticide load	1.8	1.1	0.36	0	1	0	0	2.6	0	4	0	0	0	0	0	0.28	0	0	0.0329	0
E89	Fert impregnation	10.5	91	0.27	0	1.2	0.4	13.8	3.2	0	7	0	0	0	0	0	7.9	0	0	0	0
E89	Runoff area	0.48	1.1	0	0	0	0	0	0.39	0	1.7	0.59	0	0	0	0	0.18	0	0	0	0
E89	Small pkg mix/load	0.29	0.58	0	0	0.45	0	0	0.61	0	3	0	0	0	0	0	0.16	0	0	0	0
F21	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F22	Bulk Pesticide load	1.1	0.3	0.2	0.2	0	0	0	15.1	0	2.2	0	0	0	0	0	0	0	0	0.0215	0
F22	Fert impregnation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F22	Water fill	0.2	0.1	0.1	0	0.4	0	0	3.1	0	0.2	0	0	0	0	0	0	0	0	0.0433	0
F26	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F26	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0
F28	Fert impregnation	0	0	0	0.6	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0
F28	Small pkg mix/load	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F28	Water fill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F69	Bulk Pesticide load	0.6	1.9	0.4	0	0	0	0	4.4	0	1.1	0	0	0	0	0	0.3	0	0	0	0
F69	Bulk Pesticide load	0.9	2.2	1.2	0	0	0.3	0	1.7	0	1.5	0	0	0	0	0	0	0	0	0.0048	0
F69	Runoff area	0.2	1.5	0.2	0	0	0.1	0	0.6	0	1.1	0.2	0	0	0	0	0.1	0	0	0	0

All parameters are given in parts per million.

*In this table, if a compound was not detected at or above the method detection limit, a zero (0) was entered into the table. See Table 2, page 9 for method detection limits.

Appendix 2

Soil Cleanup Goals

MINNESOTA DEPARTMENT OF AGRICULTURE • AGRONOMY AND PLANT PROTECTION SERVICES DIVISION
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SOIL CLEANUP GOALS

I. INTRODUCTION

This guidance document outlines the Minnesota Department of Agriculture's approach to determining soil cleanup goals for agricultural chemical incident sites. Included are generic preliminary soil cleanup goals based on the potential for ground water contamination as well as other factors. Final soil cleanup goals for all agricultural chemical incident sites are always site specific and are dependent upon the unique characteristics of each site.

Preliminary soil cleanup goals have been developed for the List 1, 2, 3 and certain Unique Chemistry pesticides as well as nitrogen compounds commonly monitored in soil and ground water at agricultural chemical incident investigations.

A. Pesticide Soil Cleanup Goals

Human health exposure routes, leaching of contaminants to ground water and label application rates were considered in the development of the soil cleanup goals. The soil cleanup goals based on leaching of contaminants to ground water also considered scenarios of high, moderate and low risk to ground water. The soil cleanup goals presented in Table 1 are the lowest of the human health based goals, the label application rate based goals and the goals based on leaching of contaminants to ground water using the high, moderate and low risk to ground water scenarios for each compound. Only the leaching based goals changed in each of the three ground water risk scenarios.

The soil cleanup goals for the high risk to ground water scenario in Table 1 are the default soil cleanup goals for all sites. If you believe that the characteristics of your site are more closely aligned with the moderate or low risk to ground water scenarios, then you may discuss your reasoning with MDA staff and request that the goals based on moderate or low risk to ground water be used instead of the high risk goals for your site. The characteristics of the high, moderate and low risk to ground water scenarios are outlined below in part II.C.

B. Nitrogen Soil Cleanup Goals

The soil cleanup goal for nitrate-nitrogen is 150-200 mg/kg. The soil cleanup goal for Total Kjeldahl Nitrogen is 5000 mg/kg for the upper two feet of soil and 1000 mg/kg for soil below two feet in depth.

C. Passive Degradation

Passive degradation, or the degradation of contaminants in soil without artificial enhancement of the site conditions, may be appropriate for some sites. If it appears that the contaminants will degrade in place to the applicable soil cleanup goals before the contaminants migrate to a receptor or before corrective action will occur, and if there are no direct and immediate human health or ecological impacts, then passive degradation may be appropriate. The presence of a viable bacterial population in the contaminated soil should be demonstrated through appropriate testing. Soil sampling on at least an annual basis will be required for these sites to verify that the contaminants are degrading in place and not leaching to lower depths.

Additional requirements for passive degradation will be described in a separate guidance document.

D. Use of Background Values

In some instances the levels of contaminants in soil adjoining the site may be equal to or exceed the levels of these same contaminants in soil on site. This may be the result of naturally occurring compounds, the legal application of similar products, other non-point sources of contamination or off site point sources of contamination. If you believe that background contaminant levels are appropriate soil cleanup goals for your site, then you should discuss your proposal with MDA staff and request that background contaminant levels be used as soil cleanup goals.

The information provided to MDA staff should include the use of the surrounding property, suspected sources of the background contamination, the pathway of migration from the surrounding property to the site (if appropriate) and a comparison of the leaching potential of on-site soils versus background soils. A background soil cleanup goal will generally be based on the mean value of the concentrations in at least three soil samples collected from the surrounding property. Alternative approaches such as the use of published regional background data for naturally occurring compounds will be considered on a site specific basis.

II. CRITERIA USED TO DEVELOP THE SOIL CLEANUP GOALS FOR PESTICIDES

A. Human Health Based Goals

The human health based goals were determined using standard U.S. Environmental Protection Agency (EPA) human health risk assessment methodologies modified for use in Minnesota in an unrestricted (residential) land use scenario. Human health based soil cleanup goals for each compound were calculated separately for the ingestion of incidental soil/dust and dermal contact exposure pathways. There is insufficient information available to calculate cleanup goals for the inhalation pathway. Additive risk for selected groups of compounds was not considered.

B. Label Based Goals

The label based cleanup goals are based on twice the application rate for each pesticide for a coarse to medium textured soil with less than 3% organic matter. This level is viewed as sufficiently protective of human health and the environment at most sites. Label rate based cleanup goals have been included to address the possibility of potential residual pesticidal effects of the contaminants in a non-labeled setting. Label rate based cleanup goals have also been included because the application rate is based in part on extensive ecological toxicity and environmental fate testing by the EPA. However, cleanup to label based goals may be phytotoxic to vegetation such as grass and a lower soil cleanup goal may be required for areas which are to be planted with grass or similar vegetation.

C. Soil Leaching Based Goals

The soil leaching levels are the levels above which contaminants will likely leach from contaminated soil to ground water at levels which exceed the ground water goals if the soil is left in place. The soil leaching goals were determined with an approach developed by the EPA. Partitioning of the contaminant to organic carbon in soil and to soil water was calculated using compound specific characteristics and generic soil characteristics such as organic carbon content and bulk density in an equation modified from The Soil Chemistry of Hazardous Materials (1988) by James Dragun.

Using an EPA equation that accounts for dilution of the contaminated soil water when it reaches the ground water, a generic dilution factor was calculated using parameters applicable to Minnesota, and the value obtained from the soil partitioning equation above was multiplied by this factor.

This value was further adjusted to account for chemical and biological degradation of the contaminants. Various attenuation factors were selected, based on the geology at the site, the presence of usable quantities of ground water, the actual or potential uses of this ground water and the vulnerability of this ground water to contamination. The geologic portion of the risk to ground water determination was based on a Minnesota Department of Natural Resources approach for assessing ground water sensitivity (Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota, 1991). The MDA approach focused on the presence and thickness of low permeability earth materials at the site. In general, greater thickness' of low permeability deposits will provide protection of ground water from surficial sources of contamination.

The leaching based soil cleanup goals for alachlor, cyanazine, phorate, propazine, terbufos, aldicarb and bentazon were modified slightly based on method detection limits, practical limitations and implementability at agricultural chemical incident sites.

In the following discussion the term aquifer refers to the first geologic formation capable of producing a viable water supply (at least 5-10 gallons per minute) as well as those formations that are reasonably permeable and are hydraulically connected to water producing aquifers. The term low permeability geologic materials refers to clay, shale, clay loam, clay till or glacial lake clays.

1. High Risk to Ground Water

   The leaching to ground water calculation used in the high risk to ground water scenario assumes that 1) there is little or no attenuation of contaminants within the unsaturated or saturated zones, and 2) the applicable ground water cleanup goal would be a drinking water standard.

2. Moderate Risk to Ground Water

   The leaching to ground water calculation used in the moderate risk to ground water scenario assumes that 1) low permeability geologic materials are present overlying the aquifer which increase the potential for attenuation of contaminants within the unsaturated zone; 2) there is some dilution of contaminants within the aquifer prior to migration of the contaminants to a potential receptor, and 3) there is no short term risk to receptors using the ground water downgradient of the site.

   As shown on Table 1, at sites where the aquifer is protected by at least 50 feet of low permeability geologic materials, a higher soil cleanup goal may be used for alachlor, cyanazine, phorate, terbufos and aldicarb.

3. Low Risk to Ground Water

   The leaching to ground water calculation used in the low risk to ground water scenario assumes that leaching of contaminants to ground water is minimal because of a large thickness of low permeability geologic materials. The low risk to ground water soil cleanup goals are appropriate for sites where there is approximately 100 feet of low permeability geologic materials, which will allow for significant attenuation of the contamination before it reaches the aquifer of concern. Some dilution of contaminants within the aquifer prior to migration of the contaminants to potential receptors is also assumed for these sites.

   Low ground water risk should not be assumed if unsealed or leaking wells or other mechanisms are present which may provide a direct conduit for site contamination into the aquifer of concern. If contamination from anthropogenic sources is present in the aquifer of concern then the aquifer is not well protected from surface contamination and it may be inappropriate to assume a low ground water risk for your site.

III. FINAL GOAL SELECTION

The approach used to develop the preliminary soil cleanup goals does not specifically consider the initial concentration or volume of contaminated soil; the presence of karst at or adjacent to the site; ecological, food crop or livestock risks; phytotoxicity of the contaminated soil, and discharge of contaminated ground water or runoff to surface water. These factors should also be considered when assigning final soil cleanup goals to sites.

In addition, the preliminary soil cleanup goals may be modified as appropriate based on the following factors:

1. overall protection of human health and the environment;
2. long term effectiveness and permanence;
3. reduction in toxicity, mobility and volume;
4. short term effectiveness (impacts resulting from the cleanup);
5. implementability of the remedial action and technology limitations;
6. community acceptance;
7. practicability, and
8. cost.

Table 1- Preliminary Soil Cleanup Goals

Pesticide	SOIL CLEANUP GOALS (2) (mg/kg)		
	Low GW Risk	Mod. GW Risk	High GW Risk
List 1			
Acetochlor	1.0	1.0	0.2
Alachlor (c) (1)	2.0	0.5 or 1.0 (3)	0.1
Atrazine (c) (1)	2.0	2.0	0.2
Chlorpyrifos	1.0	1.0	1.0
Cyanazine (c) (1)	1.3	0.1 or 0.2 (3)	0.1
Diallate	0.5	0.5	0.1
EPTC	4.0	4.0	4.0
Ethalfluralin	0.5	0.5	0.5
Fonofos	2.0	2.0	0.8
Metolachlor	1.5	1.5	1.2
Metribuzin	0.3	0.3	0.3
Pendimethalin	0.8	0.8	0.5
Phorate	3.7	0.6 or 1.1 (3)	0.1
Propachlor	4.0	4.0	1.1
Prometon	8.0	8.0	0.9
Propazine	1.0	1.0	0.1
Simazine (c) (1)	1.0	1.0	0.4
Terbufos	1.0	0.1 or 0.2 (3)	0.1
Triallate	1.0	1.0	1.0
Trifluralin (c) (1)	0.5	0.5	0.3
List 2			
2,4-D	0.5	0.5	0.5
2,4-DB	0.2	0.2	0.2
Chloramben	1.4	1.4	1.4
Dicamba	0.3	0.3	0.3
MCPA	0.3	0.3	0.3
MCPB	0.5	0.5	0.5
MCPP	1.1	1.1	1.1
Picloram (Tordon)	0.1	0.1	0.1
2,4,5-T	0.5	0.5	0.5
2,4,5-TP (Silvex)	0.8	0.8	0.8
Triclopyr (Garlon)	0.3	0.3	0.3
List 3			
Aldicarb	0.8	0.1 or 0.2 (3)	0.1
Carbaryl	0.5	0.5	0.5
Carbofuran	0.2	0.2	0.2
Unique Chemistry			
Bentazon	0.5	0.5	0.1
Bromoxynil	0.3	0.3	0.3
Clomozone	0.5	0.5	0.5

Footnotes:

(1) The notation (c) indicates that a compound is classified as a possible or probable human carcinogen.

(2) The soil cleanup goal is the lowest of the human health based goals, the label application rate based goals and the goals based on leaching of contaminants to ground water for each of the high, moderate and low risk to ground water scenarios for each compound.

(3) The higher cleanup goal may be used when 50 feet of low permeability geologic materials are present overlying the aquifer of concern.