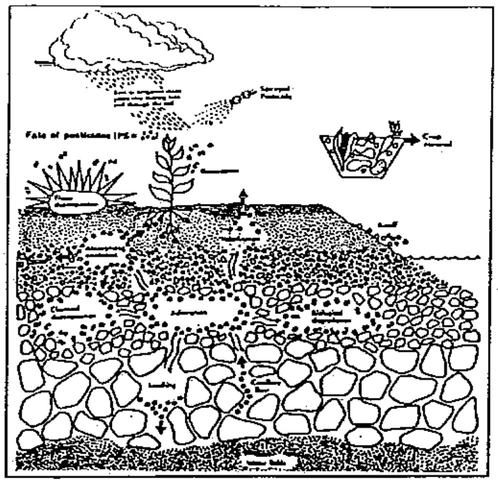
AGRICULTURAL PESTICIDE HAZARD TO GROUNDWATER IN UTAH



by

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IIC - 89/1A

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April 1989

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ABSTRACT

This study identifies agricultural pesticide usage in Utah. Processes and factors affecting pesticide movement to groundwater are analyzed. Agricultural DRASTIC, a rapid screening procedure, is used to identify sites potentially vulnerable to pesticide contamination. Pesticide movement at these sites is investigated using a one-dimensional simulation model, CMLS.

Predicted pesticide concentrations reaching the groundwater are compared to proposed health standards. Potentially hazardous site-pesticide combinations are identified and ranked. Suggested sampling sites are presented.

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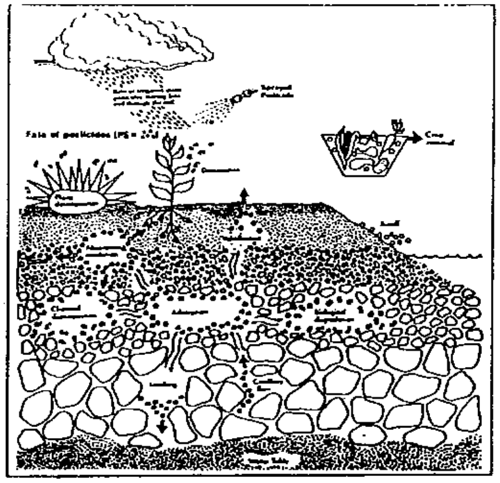
PART I: MAIN REPORT



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INTRODUCTION

Background

Pesticide sales in the U.S. are approximately 1.1 billion pounds annually. Table 1 shows their estimated use in agriculture, industries, communities and government, homes, and gardens.

TABLE 1. Volume of U.S. Pesticides Used, By Class and Sector, 1985 Estimate (Source: EPA 1987).

	(millions of pounds of active ingredients)				
	Herbicides[1]	Insecticides[2]	Fungicides[3]	Other[4]	Total
Agriculture	525	225	51	60	861.0
Ind./Comm./Govt.	115	40	21	.1	176.1
Home & Garden	30	35	12	.1	75.1
Total	670	300	84	60.2	1112.2

1 Includes plant growth regulators.
2 Includes miticides and contract nematicides.
3 Does not include wood preservatives.
4 Includes rodenticides, fumigants, and molluscides.

The use of pesticides is an integral part of today's agriculture. There is no doubt that in many cases, pesticides safeguard crops from severe pest infestation, or increase yield by suppressing competing weed growth. Often, pesticides may make the difference between profits and losses in farming operations. However, pesticides, even in extremely low concentrations, can pose a risk to human health and to the environment. Applied to plant or soil surfaces, or injected into subsoil layers, pesticides may leach to the groundwater or may be washed off with surface water. Pesticide contaminated surface water may reach groundwater, or vice versa, contaminated groundwater may surface and contribute to surface water pollution.

Once in the groundwater, pesticides may persist for years, rendering the water unsuitable for human and animal consumption. Effectively treating drinking water to reduce pesticide residues to acceptable levels, or restore groundwater quality, may be extremely difficult and expensive.

In many states, recent sampling revealed pesticide contamination of groundwater. Parsons (1988) based on a national survey notes:

> "The principal criterion for whether pesticides had been detected in the groundwater in a state appears to be whether or not they have looked. The information on occurrences of pesticides in groundwater is burgeoning to the point that it is difficult to assemble an accurate overview of the nature and scope of the national problem."

The Problem

In Utah, groundwater is a valuable and necessary resource. Waddell (1987) states: "About 63 percent of Utah's population depends on ground water for drinking supplies". In rural areas, groundwater is often the only source of drinking water. However, in some of these areas, groundwater is close to the surface and therefore easily subject to contamination by agricultural chemicals. There may be up to 50,000 wells statewide, supplying water for various purposes.

In its "Groundwater Quality Protection Strategy" (1986), the Utah Department of Health calls for the identification of potential and existing groundwater quality problems. Taking water samples from existing wells is the obvious choice in assessing existing problems, however, comprehensive sampling of existing wells is not feasible. Therefore, an educated selection of representative sampling sites is desired.

Objectives and Limitations

The potential vulnerability of groundwater to pesticide contamination is dependent on many factors. Significant variation of the factors in time and space adds to the complexity of any analysis.

The objective of this study is to determine the areas in Utah where particular combinations of pesticides, soil and water management practices, soils and geology pose the greatest hazard to groundwater quality. Once identified, those areas may attract special attention in future water sampling and/or soil management programs.

This study does not address the potential hazards to groundwater quality due to:

1. Pesticides applied in forests, rights-of-way and range land (the "Ground Water Quality Protection Strategy for the State of Utah" mentions that an estimated 25,000 pounds of active ingredients were used in 1980 in these locations);
2. Pesticides applied in home gardens;
3. Pesticides used in mosquito abatement programs in urban areas; and
4. Pesticide movement in horizontal direction.

The study assumes that pesticide applicators follow the instructions given on the product labels. Accidental spills and leakage of pesticides as well as inadequate disposal of containers are not addressed.

Methodology

Factual data on pesticide applications in Utah are needed to assess the potential hazard that pesticides may pose to groundwater. A survey, completed by extension personnel and pesticide retailers as part of this project, provides insight to statewide usage of pesticides.

An array of site specific factors affects pesticide movement on the surface and into groundwater. Rapid screening of this abundant data is required to separate potentially safe site-factor combinations from potentially hazardous site-factor combinations. The data will be analyzed in detail using a computer simulation model.

The following stepwise procedure will be adopted:

1. Collection of factual data on pesticide application including areas of pesticide use, crops pesticides are used on, types of pesticides used, and pesticide application practices;

2. Evaluation of factors affecting pesticide surface runoff and pesticide leaching to groundwater;

3. Selection and application of a "hazard to groundwater" screening model;

4. Selection of a one-dimensional pesticide transport model and application of the model to sites identified by the screening model;

5. Regional comparison of predicted vertical pesticide movements and relation to health advisories; and

6. Identification of areas where pesticides might pose a threat to groundwater quality.

PESTICIDES: AN OVERVIEW

Types and Formulations

Pesticides are substances or mixtures of substances used to kill, destroy, repel, or regulate pests such as insects, rodents, birds, weeds, unwanted plant growth, molds, fungi, bacteria, and other microorganisms. They are chemicals that have biological activity against the pest to be controlled, and they can be toxic to man, animals, or the environment if sufficient dose and exposure occur from improper use or disposal.

Most pesticides now being used are organic and vary in molecular structure from simple to very complex. Inorganic pesticides were used mostly before the 1950's, although a few are still in use today.

There are many types of pesticides (Table 2) available in a variety of formulations (Table 3). As of 1986 the EPA registered approximately 45,000 products as pesticides, formulated from about 1,400 different active ingredient chemicals, manufactured or formulated by more than 3,400 different companies, and distributed by more than 29,000 distributors.

Pesticides are used extensively in agricultural, public health and environmental programs. Herbicides are used on nearly 90% of all agricultural acreage, while insecticides and fungicides are used on about 30 and 10 percent respectively. Both federal and state laws make users of pesticides responsible for properly applying their pesticides according to label directions and for properly disposing of excess pesticides and their containers.

Mechanisms of Toxicity

Pesticides have various mechanisms of toxicity. Many are contact poisons and affect the surface that they come in contact with, or affect animals

TABLE 2. Types of Pesticides

Acaricides - mites, ticks	Insecticides - insects
Algicides - algae	Miticides - mites
Attractants - animals	Molluscicides - mollusks
Avicides - birds	Nematicides - nematodes
Bactericides - bacteria	Ovicides - eggs
Desiccants - water removal	Pediculicides - lice
Defoliants - foliage removal	Pheromones - insects
Disinfectants - microorganisms	Pisicides - fish
Fumigants - insects, rodents, weeds	Predacides - predators
Fungicides - plant pathogens	Repellents - animals
Germicides - germs	Rodenticides - rats, mice
Growth Regulators - insects, plants	Sanitizers - microorganisms
Herbicides - weeds	Sterilants - microorganisms
Hormones - insects, plants	Wood Preservatives - fungi, insects

TABLE 3. Pesticide Formulations

Emulsifiable Concentrates	Soluble & Wettable Powders
Concentrate Solutions	Granules
Ready to Use Solutions	Dusts
Dry Flowables	Baits
Aerosols	Volatile Solids & Liquids
Pressurized Gases & Liquids	Pellets
Microencapsulations	Tablets
Invert Emulsions	Water Dispersible Granules

(including insects) that come in contact with the treated surface. Some contact pesticides have no residual effect, while others have a variable residual period. Periods are usually less than 2 months, often only a few days. Some pesticides are systemic or translocatable and are absorbed and then transported internally throughout the system of either the plant or animal. Some pesticides are stomach poisons, affecting animals only after consumption.

Historic Background and Legislation

The use of chemical pesticides increased significantly near the end of the 19th century. At that time only a few simple formulas existed and pesticide products were made by many small companies and often prepared by the farmers themselves after mail ordering the basic active ingredients. Congress became concerned about the sale of substandard or fraudulent pesticides. In order to protect the farmer, the Federal Insecticide Act of 1910 was passed.

In 1947 the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) was passed. This act required pesticides to be registered with the USDA and required that they be labeled according to established standards. This law assumed that the pesticide user was a rational person and if sufficient information were provided through labeling, proper pesticide selection and use would occur. The focus of the law at this time was primarily on pesticide efficacy. Less concern was placed on effects to nontarget species and environmental protection.

In 1970 the Environmental Protection Agency (EPA) was formed and assigned the responsibility of enforcing FIFRA. EPA was also given the authority to establish tolerances for pesticide residues in edible foods, feed, and their packaging materials. The Food and Drug Administration (FDA) was charged with enforcing those tolerances by testing these items for chemical residues.

FIFRA was amended by the most detailed and comprehensive pesticide legislation in history, the Federal Environmental Pesticide Control Act (FEPCA) of 1972. The amendments recognized the need to protect the general public and environment from the potentially harmful effects of pesticides. The consumer protection objectives were maintained as well. The core of the amendments was the requirement that EPA deny registration to a pesticide unless it could determine that "when used in accordance with widespread and commonly accepted practices it will not cause unreasonable adverse effects on the environment". The unreasonable adverse effect is further defined as "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide".

This definition essentially required the EPA to conduct balanced risk versus benefit analyses for all pesticide uses. Congress recognized that pesticides will inherently cause some risks because of the type of biologically active chemicals that they are. Congress wanted that risk balanced against benefits derived from using pesticides.

In Utah, all pesticides that are sold or used must be registered by the Environmental Protection Agency (EPA) and the Utah Department of Agriculture. This requirement is found in the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Utah Pesticide Control Act of 1979.

In addition to FIFRA, the following federal laws pertain to pesticide use and disposal: (Agricultural Chemicals in Ground Water 1987)

- The Safe Drinking Water Act (SWDA) is designed to ensure that public water systems provide water meeting minimum standards for protection of public health. As required by the Act, EPA establishes drinking water standards (Maximum Contaminant Levels) and water supply monitoring requirements for public water supplies to meet.

  Under recent amendments to the Act, the Agency has been authorized to provide resources to States to establish "Wellhead Protection Areas" (WHPA) for public drinking water wells. Other recent amendments restrict underground injection of hazardous waste and establish a sole source aquifer demonstration program.

- Clean Water Act (CWA) The basic mission of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. EPA provides grants to States for development and implementation of State ground-water protection strategies. Under the CWA's nonpoint source authorities, EPA also provides financial assistance to States for nonpoint source monitoring/assessments, planning, program development, and demonstration projects.

- The Resource Conservation and Recovery Act (RCRA) regulates disposal of waste, including pesticides, which may create a hazard. Pesticide-containing wastes that are considered hazardous wastes under RCRA are subject to extensive regulatory requirements governing storage, transportation, treatment, and disposal.

- The Comprehensive Environmental Response, Compensation and Recovery Act (CERCLA) establishes a trust fund (Superfund) to finance government responses to releases or threats of releases of hazardous substances. However, if ground-water contamination results from normal application of pesticides, the law does not allow the Agency to recover costs from pesticide applicators or private users.

Health Risk and Health Advisory

Public concern about pesticides and their affects on human health are thriving, but how do pesticides really effect us? Two different health effects may be distinguished:

1. Short-term exposure to relatively high doses of various pesticides may induce an acute poisoning; and

2. Long term exposure to trace concentrations (a few parts per billion or even per trillion) in food, drinking water or the general environment, may induce chronic health effects.

Nowadays, concern is mainly focusing on the effects of long term exposure. Cancer, mutations, birth defects, and immunological changes are mentioned as possible effects of long term low level exposure. However, it is essential to indicate that the mere presence of trace concentrations does not necessarily present an unreasonable risk. USEPA (1987) mentions in its proposed pesticide strategy:

> "The level of risk posed by pesticide residues is dependent upon the levels and duration of human exposures to residues of pesticide and the toxicological significance of such exposure".

If a certain level of risk can be defined as acceptable, then it is possible to formulate health advisories. These advisories may indicate the pesticide concentration that can be consumed during a certain time period without anticipation of adverse health effects.

The Office of Drinking Water of the Environmental Protection Agency currently provides health advisories for 60 pesticides. This office developed one-day, ten-day, long term (approximately 7 years) and lifetime exposure limits based on non-carcinogenic end points of toxicity. For the chemicals that are known or probable carcinogens, concentration values are correlated with carcinogenic risk estimates. The acceptable risk is set at a level of 10^{-6}, this means that at the given level of exposure, one person in a million might contract cancer if exposed for his entire lifetime to the level given by the health advisory (USEPA Office of Drinking Water, 1987). Table 4 provides a listing of the Office's lifetime health advisories. The data in Table 4 currently have non-regulatory status. However, EPA may declare these values as <u>Maximum Contamination Levels</u> (MCL's), which are enforceable standards as defined under the Safe Drinking Water Act.

After carefully analyzing the calculation of health advisories, one may notice that considerable judgement is involved in defining acceptable risk and

TABLE 4. Lifetime Health Advisory (USEPA Office of Drinking Water, 1987)

Chemical Name	Cancelled or Severely Restricted	Health Advisory Level** (ppb)
1,2-D	Y	0.0013 *
1,3-D		0.20 *
2,4,5-T	Y	21
2,4-D		70
2,4-DB		
Alachlor		1.5 *
Aldicarb		10
Aldrin		
Arsenic	Y	
Atraton		
Atrazine		3.0
BHC	Y	
Bromacil		80
Carbofuran		36
Chlordane	Y	0.03 *
Chlorothalonil		1.5 *
Cyanazine		9.0
DBCP	Y	0.02 *
DDT		
Dacthal/DCPN		3500
Diazinon		0.63
Dicamba		9.0
Dieldrin	Y	0.00219 *
Dinoseb	Y	7.0
Diuron		14
EDB	Y	0.0005 *
Endosulfan		
Endrin	Y	0.032
Ethoprop		
Fonofos		14
Heptachlor	Y	0.076 *
Hexazinone		210
Lindane	Y	0.026 *
Linuron		
Malathion		
Methamidophos		
Methomyl		175
Methyl parathion		2.0
Metolachlor		10
Metribuzin		175
Oxamyl		175
PCNB		
PCP		220
Parathion		

TABLE 4. Lifetime Health Advisory (cont.)

Chemical Name	Cancelled or Severely Restricted	Health Advisory Level** (ppb)
Picloram		490
Prometon		100
Propazine		14
Silvex	Y	52
Simazine		35
Sulprofos		
TDE	Y	0.031
Toxaphene	Y	
Triallate		
Trifluralin		2.0

* Lifetime exposure levels based on a 10^{-6} risk of causing cancer

** Proposed Lifetime Health Advisory Level

acceptable contamination levels (e.g. extrapolation of results gained from laboratory tests with animals, selection of safety factors, definition of carcinogenic risk). Rao (1988) comments on this point and the formulation of regulatory guidelines:

> "Risk assessment is judgement based on scientific data and provides a rational basis for quantifying the hazards of groundwater contamination. Risk management usually involves social, legal, economic, and political considerations. If a given level of excess risk is determined to be acceptable, especially in comparison with other risks that may be greater but are usually taken for granted in every-day life, then appropriate regulatory guidelines for preventing or minimizing groundwater contamination can be developed".

Authorities and Institutional Framework Related to Pesticide Usage

At the federal level, three agencies have jurisdiction over pesticides in groundwater. Table 5 gives an overview of these agencies.

TABLE 5. Agencies with Pesticide/Groundwater Regulations.

Agency	Division	Activity
U.S. Department of Agriculture	- Extension Service - Soil Conservation Service - Agricultural Stabilization and Conservation Service - Agricultural Research Service	Assistance to landowner regarding pesticide selection, Research and pesticide application
U.S. Department of Interior	U.S. Geological Survey	Gathering hydrogeologic information on aquifers. Assessing water quality in aquifers.
Environmental Protection Agency	- Office of Groundwater Protection - Office of Drinking Water - Office of Water Regulations and Standards - Office of Pesticide Programs	Lead responsibility in protecting groundwater quality. Regulation of pesticides.

PROCESSES AND FACTORS INFLUENCING PESTICIDE MOVEMENT

Processes Influencing Pesticide Movement

Several processes influence pesticide movement. Figure 1 and Table 6 give an overview of the processes involved.

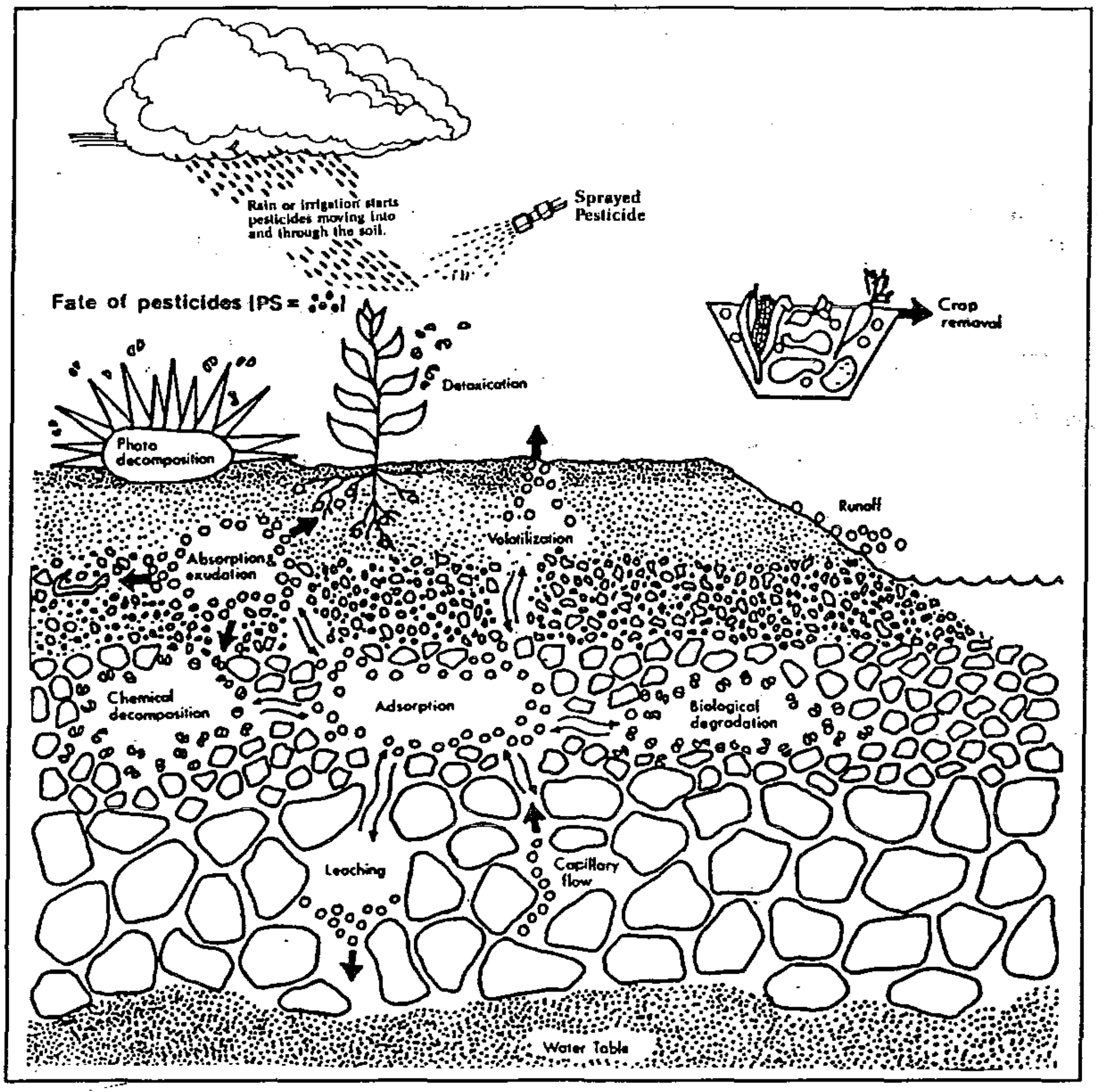


Figure 1. Processes Influencing Pesticide Movement (Source: Adapted from Rao (1983).

TABLE 6. Processes Influencing Pesticide Movement

Main Category of processes	Sub Category of processes
Sorption	Adsorption Desorption
Dissipation (Degradation)	Photodecomposition Chemical Decomposition (Hydrolysis)
	Biological Degradation (Assimulation)
Volatilization	Diffusion
Application	Aerial Incorporated
Water Movement	Water Supply (Rainfall, Irrigation), Leaching
Water Removal	(Plant Uptake, Runoff), Evaporation
Plant Uptake	Transpiration

Each process may be affected by several factors. Additionaly, processes as well as factors may be interdependent.

Factors Influencing Pesticide Movement Processes

Table 7 gives an overview of factors affecting pesticide movement and relates the factors to the movement processes. The listing and the linking to the processes is not all-inclusive. To the extent possible, the following discussion describes processes under the heading of the most important influencing factors.

TABLE 7. Grouping of Factors Influencing Pesticide Movement

Main Category of factors	Sub Category of factors	Processes Affected
Physical-Chemical Properties of Pesticide	Half-Life (Persistence)	Dissipation, Plant Uptake
	Organic Carbon Partition Coef.	Sorption, Runoff, Leaching
	Solubility	Sorption, Runoff, Leaching
	Melting Point	Volatilization
Soil	Organic Matter	Sorption, Dissipation, Water Movement
	Texture	Water Movement, Sorption
	Structure	
	Clay Content	Sorption, Water Movement
	pH	Adsorption, Dissipation
	Moisture	Water Movement
	Temperature	Sorption, Degradation
Agricultural Practices and Plant Uptake	Pesticide Application	Plant Uptake
	Soil Management	Water Management
	Irrigation	Water Movement, Dissipation

TABLE 7. (continued)

Main Category of factors	Sub Category of factors	Processes Affected
Hydro-Geology	Depth to Groundwater	Water Movement, Dissipation
	Geological Formation	"
	Hydraulic Conductivity	"
	Confining Beds	"
Climate	Rainfall	Water Movement, Dissipation, Plant Uptake
	Temperature, Sunshine	Volatilization, Plant Uptake, Dissipation
	Humidity	Plant Uptake, Volatilization
	Wind	Water Movement Volatilization
Topography	Slope	Water Movement, Run off

<u>Pesticide</u>

Physical-chemical properties, especially half-life time, bonding power (sorption) and solubility, are among the most important factors influencing pesticide movement.

Sorption and Physical-Chemical Bonding

Sorption may be defined as the chemical-physical bonding of a pesticide molecule to a solid surface such as a soil particle. Adsorption refers to the adherence of molecules, whereas desorption refers to the separation of molecules from soil particles. "The system strives toward attaining an equilibrium between adsorbed and desorbed phases based on the relative amounts of the pollutant in each of the solid, liquid, or vapor phases" (Wood, 1984, p. 21). Concentrations in the adsorbed phase and in the desorbed phase are related by the Freundlich isotherm:

$$S = K * C^n \qquad (1)$$

where: S = Concentration in the adsorbed phase (mass of contaminant per mass of adsorbent)

C = Concentration in the dissolved phase (mass of contaminant per volume of water)

K,n = Constants

Commonly, n is assumed to be equal to 1 and equation (1) may be written as:

$$K_d = S/C \qquad (2)$$

where K_d is the soil partition coefficient. K_d expresses the equilibrium condition between adsorbed mass and desorbed mass. Adsorption/desorption processes depend on the physical-chemical bonding power of the pesticide molecules as well as of the soil particles, and each soil may have a different K_d value. One approach to normalize the soil partition coefficient is to relate the K_d value to organic carbon in the soil:

$$K_d = K_{oc} * OC \qquad (3)$$

$$K_{oc} = \frac{\text{microgram pesticide adsorbed per g of organic carbon}}{\text{microgram pesticide in solution per gram of solution}} \qquad (4)$$

where: K_d = Soil partition coefficient

K_{oc} = Organic carbon partition coefficient

OC = Organic carbon in as a fraction

K_{oc} values can easily be measured in laboratory experiments, and organic carbon is routinely determined in soil laboratory analysis.

As one can see, by combining equations (2), (3) and (4), the higher the K_{oc} value, then the higher the concentration that is in the adsorbed phase, and the smaller the leaching potential of the pesticide. Adsorption can explain the often very slow migration of pesticides through soil.

Dissipation and Half-Life

The processes dissipation, degradation and persistence express the process of the disappearance of the pesticide from the soil surface or subsurface. The slower the dissipation or degradation of a pesticide, the longer its persistence. Persistence is usually expressed with the term half-life which is the time (in days) it takes for one half of the substance to be degraded or broken down to simpler compounds. Often, dissipation is expressed by a dissipation rate constant K_s. The half-life and the dissipation rate constant are related by the following equation:

$$K_s = 0.693 * 1/t_{1/2} \qquad (5)$$

where: K_s = Dissipation constant in $days^{-1}$

$t_{1/2}$ = Half-life time in days

Pesticide dissipation is based on a combination of processes. These include volatilization (the loss of compounds to the atmosphere), hydrolysis (acidic-basic reactions), and biotic and abiotic absorption. Experimental data indicate that pesticide dissipation is considerably faster from the soil surface than from the subsurface (Leonard et al., 1987), faster in the root zone than below the root zone, and much faster under unsaturated conditions than under saturated conditions (Carsel, 1984).

Pesticide dissipation depends on the chemical structure of the compound. Most breakdown products are less harmful than the original product, however, certain pesticides may produce potentially more hazardous breakdown products.

The pesticide data bank in Appendix C provides information on half-life values and organic carbon partition coefficients. Pesticides listed in this appendix are used in Utah.

<u>Solubility</u>

A pesticide's solubility value indicates its ability to dissolve in water. However, according to Leonard et al. (1988) "solubility will limit herbicide transport in leachage only for specific combinations of K_{oc}, S, and application rate".

Solubility is related to the organic carbon partition coefficient (K_{oc}), except for a few pesticides having high crystal energy and high melting point (e.g. simazine). Therefore, leaching predictions do not necessarily require the knowledge of solubility values.

Physical-chemical leaching potential

A pesticide physical-chemical potential to leach depends on its persistence in soil and its lack of binding to the soil (USEPA, 1987). Hornsby (1988) combines the two influencing factors in a graphical representation as indicated in Figs. 2 and 3.

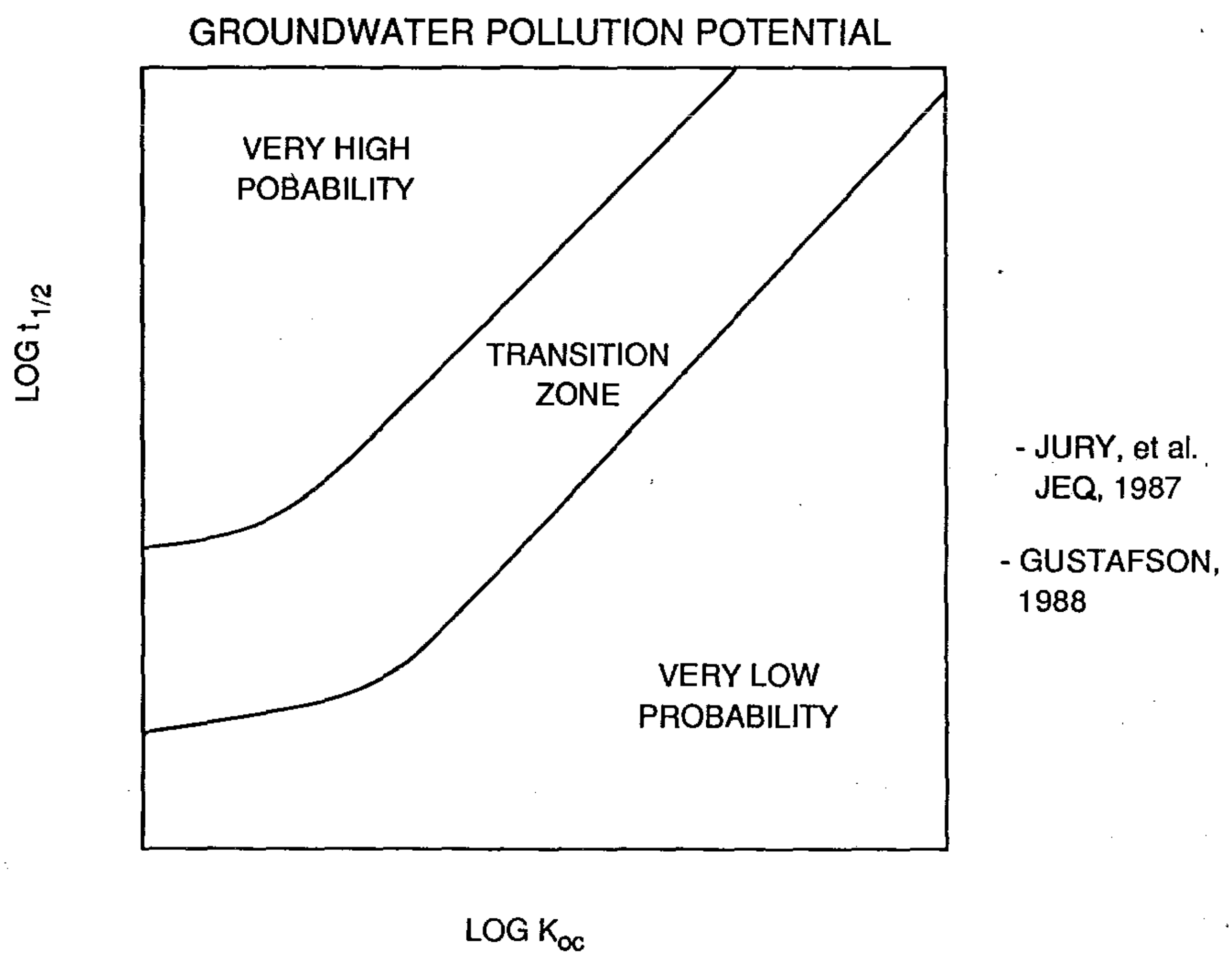


Figure 2. Zones of ground water pollution potential (from Hornsby, 1988)

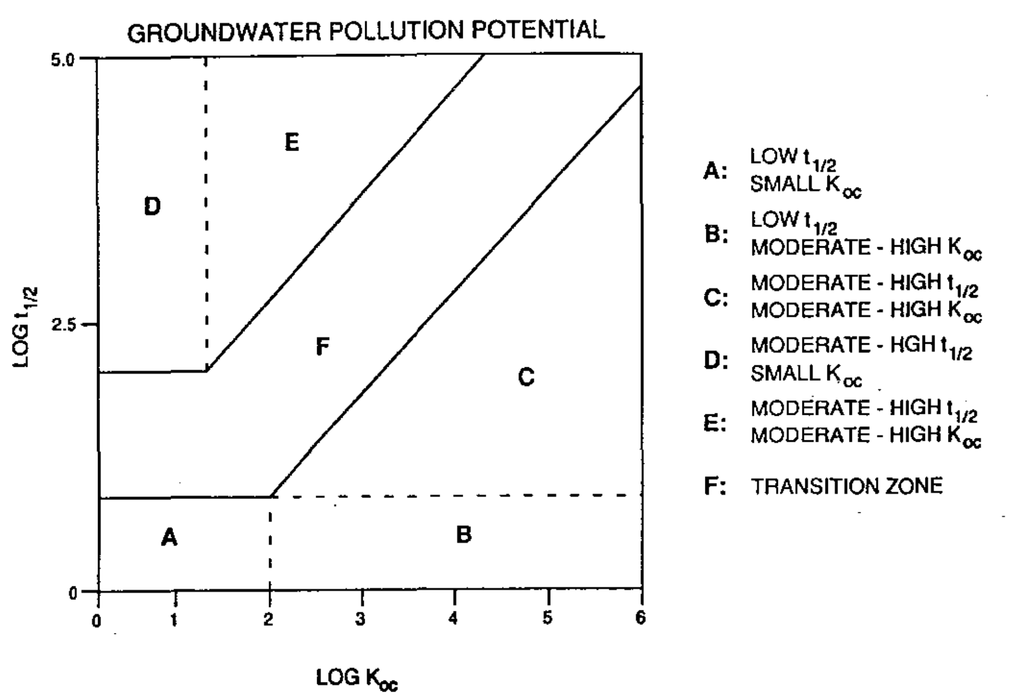


Figure 3. Half-life and Organic Carbon Partition Coefficient Related to Groundwater Pollution Potential (from Hornsby, 1988)

Soils

Organic matter content, texture, structure, pH, moisture content, and temperature may affect water movement in soil, runoff, sorption, dissipation, and plant uptake.

Organic Matter

Besides the organic carbon partition coefficient (K_{oc}), organic matter is the most important factor influencing sorption processes. Organic matter molecules dominate the adsorption/desorption process of nonpolar organic compounds. Microorganisms "feed" on the hydro-carbons of the pesticides and absorb them. Equations (1), (2) and (3) indicate the influence of organic matter. Notice the use of the term organic carbon instead of organic matter in equation (3). Laboratory analysis of soil samples usually indicate organic carbon in percent of the total weight of the soil sample. In Utah it has been observed that organic matter content is about 1.7 times organic carbon content (personal communication with USU Soil Labratory, 1989).

Texture

Texture is defined as "the size of particles making up a soil " (Hansen ed al., 1980). Soil texture affects water movement and sorption processes. Soils with a high clay content have a low infiltration rate. On those soils, water and pesticide runoff may be high.

Texture affects the water holding capacity, the soil water available to the plant, and the pesticide/soil particle contact. A light textured soil generally has a low water holding capacity. Infiltration may easily exceed the water-holding capacity of the soil and water and pesticides may quickly move below the root-zone and possibly to the groundwater.

Structure

Structure is the size, shape, and arrangement of primary particles to form compound particles and the size, shape, and arrangement of compound particles (Hansen et al., 1980). Structure and texture affect the pore volume in soils. Macro-pores may be mainly responsible for rapid transport of pesticides to deeper soil layers.

It is appropriate to mention in this context the phenomenon of "fingering". Fingering is the constriction of flows in the unsaturated zone to preferred flow paths (Hillel and Baker, 1988). Through macro-pores, fingering may rapidly transport pesticide to deeper soil layers.

Clay Content

Certain clays such as montmorillonites and smectites shrink and swell depending on soil moisture. The cracks formed on drying, close as the clay hydrates. However, initial wetting may rapidly move water and pesticides below the root zone. Aller et al. (1985) notes: "In general, the less the clay shrinks and swells, and the smaller the grain size, the less the pollution potential". Non-shrinking clays such as illites or kaolinites have a low pollution potential.

Agricultural Practices

Agricultural practices, including the method of applying pesticides, soil management and irrigation methods may have significant impacts on pesticide movement and plant uptake.

Pesticide Application and Plant Uptake

Pesticides may be applied as solids, solutions, dispersions, or emulsions to plant and/or soil surfaces. Using tillage equipment, some surface applied pesticides may be incorporated into soils.

Pesticide movement may be influenced significantly by foliar and root absorption, foliar wash-off, and volatilization from plant surfaces. To our knowledge, site independent data quantifying these values are not yet available.

Pesticide incorporation into soil affects pesticide movement. Often, organic matter affecting pesticide sorption is highest in the top few centimeters of a soil. Direct application of pesticide below this top layer (e.g. to protect corn against rootworms) generally results in increased leaching of pesticides.

Soil Management

Infiltration, surface runoff and soil erosion affect pesticide leaching. Pesticides applied to plant or soil surfaces may be lost to runoff (in solution or attached to soil particles). Soil management practices, namely timing, frequency, depth, and direction of plowing and/or disking, as well as the treatment of crop residues immediately after harvest (no treatment, incorporation, burning), may influence the balance between infiltration and surface runoff. Obviously, contour plowing and disking increases surface retention of water and consequently infiltration. Burning of crop residues decreases resistance to surface flow and increases surface runoff and/or wind erosion.

One may argue that reduced infiltration and increased runoff reduces leaching to groundwater and therefore reduces pesticide movement to groundwater. This may hold true, on a very limited observation scale. However, surface runoff often infiltrates at a different place under less favorable conditions (rapid infiltration, reduced pesticide dissipation). Contamination of surface water should not be regarded as a lesser problem. Furthermore, certain pesticides need to infiltrate in order to reach their target.

Irrigation

Basin, border, furrow, sprinkler, and trickle irrigation are field application methods. Crop value, sophistication of the application method, and irrigation efficiency are often linked. Irrigation efficiency is said to be low, if a considerable part of the applied water is lost to runoff or deep-percolation. It generally holds true that farmers tend to over-irrigate their crops if water availability is not restricted. In other words, farmers apply more water than the soil possibly can store in the root zone.

Since soil water and pesticide movement are directly related, over-irrigation results in increased pesticide movement. Generally, the larger the water movement, the larger the pesticide movement. Careful timing of pesticide and irrigation applications and irrigation doses are required. In certain cases, an irrigation immediately after pesticide application may result in excess pesticide loss; in other cases, a light irrigation immediately after pesticide application may be required to transport the pesticide to its target place, the plant roots.

Chemigation involves the simultaneous application of agricultural chemicals and irrigation. Extreme care is recommended for the control of chemical and irrigation rates as well as for the mixing process. Olexa (1984) notes:

> "Injection of crop management materials such as fertilizers and agrichemicals into an irrigation system which is not carefully designed and safely managed can result in serious groundwater contamination and legal consequences of significant magnitude".

Hydro-Geology

Depth to groundwater, geologic formation characteristics, hydraulic conductivity, and confining beds influence water movement and pesticide dissipation. While soil mainly influences vertical movement of water and surface runoff, geologic formation may influence vertical and horizontal water movement.

Depth to Groundwater

The larger the distance from the soil surface to the groundwater, the longer the pesticide dissipation opportunity. However, pesticide dissipation is considerably slower below the root zone than in the root zone (reduced biotic absorption, less adsorption, lower temperature).

Geological Formation and Hydraulic Conductivity

Water movement in the unsaturated as well as in the saturated zone is related to pore space, which in turn depends on the geological formation. Table 8 gives an overview of geological formations and types of porosity.

TABLE 8. Geological Formation and Type of Porosity (Todd, 1980).

Type of Porosity	Sedimentary			Igneous and Metamorphic	Volcanic	
	Consolidated	*Unconsolidated*	*Carbonates*		*Consolidated*	*Unconsolidated*
Intergranular		Gravelly sand Clayey sand Sandy clay		Weathered zone of granite-gneiss	Weathered zone of basalt	Volcanic ejecta, blocks, and fragments Ash
Intergranular and fracture	Breccia Conglomerate Sandstone Slate		Zoogenic limestone Oolitic limestone Calcareous grit		Volcanic tuff Cinder Volcanic breccia Pumice	
Fracture			Limestone Dolomite Dolomitic limestone	Granite Gneiss Gabbro Quartzite Diorite Schist Mica schist	Basalt Andesite Rhyolite	

Water and pesticide movement in formations with large clay content and only intergranular porosity may be extremely slow, whereas movement in fractured limestone may be very fast.

For practical work in groundwater hydrology, the hydraulic conductivity is used. Todd (1980) formulates:

> "The hydraulic conductivity of a soil or rock depends on a variety of physical factors, including porosity, particle size and distribution, shape of particles, arrangements of particles, and other factors" (p. 69).

The higher the hydraulic conductivity, the faster the water movement in the saturated zone.

Confining Beds

In certain areas, a confining bed restricts vertical flow. The confining layer may separate a shallow and a deep aquifer. It is assumed that the confining layer restricts pesticide movement into the deeper aquifer. However, interaction between the two aquifers is possible, and the mere existence of a confining layer does not always guarantee an absolute confinement.

Climate

Rainfall, temperature, sunshine hours, wind and humidity may affect pesticide movement.

Rainfall

Oliver (1987) notes:

> "In most situations, rainfall will be the main driving force for pesticide movement through the soil, and if all other parameters are the same, deeper leaching would be expected at sites with greater rainfall" (p. 55).

For the arid West, this statement is modified to include "rainfall and irrigation".

Rainfall intensity, distribution, and timing after pesticide application have a significant impact on movement. Higher movement is expected in areas with frequent heavy rainfalls. Knisel et al. (1980) indicate that "pesticide removal from leaf surface is greatest if rainfall occurs within 24 hours after pesticide application" (CREAMS Manual p. 596).

Rainfall intensity and distribution affect surface runoff and erosion. A discussion of this topic is provided in the section "soils".

Temperature, Sunshine and Wind

Temperature, sunshine and wind affect water removal from soils, volatilization, and photodecomposition of pesticides. Water evaporation from the soil surface may actually initiate an upward movement of pesticides. Plant transpiration removes water (and pesticide) from the soil profile, and reduces downward movement.

Air temperature and sunshine affect soil temperature. The temperature dependence of dissipation processes is discussed under "soils". It is important to note that under frozen soil conditions, pesticide movement and dissipation are halted.

Humidity

Knisel et al. (1980) indicate that:

> "High humidity has been reported to increase pesticide persistence on plants by facilitating foliar absorption through favoring stomatal opening and slowing drying time, and to decrease persistence by favoring volatilization" (CREAMS manual p. 596.

Topography

Topography, together with soil properties (infiltration), affect the distribution between water infiltrated into the soil and water lost to runoff. The steeper a slope, the higher the potential for runoff losses and soil erosion.

Pesticide may be washed off in solution or attached to soil particles. Leonard et al. (1988) relates the importance of runoff losses also to the half-life of pesticides. They note:

> "Losses in runoff water were about 10 times greater from a heavy soil then from a sandy soil. Losses of runoff-transported, sediment-sorbed pesticides from the heavy soil were about 100 times greater than those from the sandy soil. For both soils, losses increased with increasing herbicide half-life. Losses were very low for K_{oc} smaller than 100 because in this K_{oc} range, the dominant pathway of herbicide transport from the surface soil layer is vertical with infiltrating rainfall rather than horizontal in runoff" (p. 212).

ASSESSING POTENTIAL HAZARD OF PESTICIDES TO GROUNDWATER QUALITY IN UTAH

The Survey

Accurate information on pesticide usage in Utah is required in order to assess the potential hazard to groundwater. Results of a survey conducted in 1978 were judged to be incomplete and outdated. Therefore, a new survey was designed and conducted.

When conducting a survey, one needs to select appropriate survey respondents in order to receive a representative picture of reality. Utah has about 13,600 farms (DelRoy, 1988). Surveying even five percent of them would have been impossible for the resources of this study. However, county agents of the Utah State University Cooperative Extension Service are familiar with farming operations in their counties. This source of information was utilized for the survey.

Data surveyed were:

1. Crop rotation for a particular farm

2. Crop:	- Name - Planting date - Date of emergence - Date of maturity - Date of harvest
3. Pesticide application:	- Name - Formulation - Application date - Application rate
4. Irrigation:	- Method - Rate - Frequency - Duration - Starting date in season
5. Soil:	- Type

Survey forms and instruction guide are included in Appendix E.

Survey respondents were requested to provide information on their crop rotation. This was judged necessary since a intraseasonal cumulative effect of highly persistence pesticides and pesticide metabolites may occur. Pesticide metabolites are not analyzed in this study, although, survey results may be used for future studies. The survey respondents were also requested to sketch crop rotation patterns on 1:100,000-scale topographic maps.

Rapid Assessment of Groundwater Vulnerability

Pesticide hazard to groundwater depends on an array of site-specific factors and factor-combinations. Assessing groundwater vulnerability in a spatially extended and highly variable system such as the state of Utah, is bound to produce an overwhelming wealth of data. The use of a rapid assessment or screening procedure became absolutely essential. With its help, potentially safe site-factor combinations can be identified and excluded from further investigation, whereas potentially hazardous site-factor combinations can be targeted for intensive attention.

Evaluation of Screening Procedures

For the purpose of this study, three screening tools are evaluated: DRASTIC (Aller et al., 1985), SEEPPAGE (Moore et al., 1988), and SOI (Goss, 1988). A brief overview of the three procedures follows.

DRASTIC:	A Standardized System for Evaluating Groundwater Pollution Potential Using Hydro-Geologic Settings.
Developed by:	National Water Well Association / Environmental Protection Agency

Purpose:

1. To serve as a screening tool for the systematic evaluation of the relative vulnerability of areas to groundwater contamination.

2. To help direct resources, waste disposal, and other land-use activities to appropriate areas.

Factors used:

1. D = Depth to groundwater
2. R = Net recharge
3. A = Aquifer media
4. S = Soil media
5. T = Topography (slope)
6. I = Impact of the vadose zone
7. C = Hydraulic conductivity

Methodology: Quantitative ranking of factors; weighted summation yields a total score.

Result: Numerical value called DRASTIC index. The higher the index, the greater the groundwater pollution potential, however, the index is a relative value to be used only for comparative assessments.

SEEPPAGE: A System for Early Evaluation of the Pollution Potential of Agricultural Groundwater Environments.

Developed by: Soil Conservation Service

Purpose:

1. To serve as a screening tool early in the conservation planning process when sites for practices are being selected.

2. To allow the user to compare the relative risks of groundwater contamination among various sites and to select the most favorable site.

3. To identify when a specialist is needed, or when a more detailed, site-specific evaluation is necessary.

4. To provide insight on how either the site or the practice may need to be modified to provide for protection of groundwater.

Factors used:

1. Horizontal distance between site and point of water use
2. Land slope
3. Depth to water table
4. Vadose zone material
5. Aquifer material
6. Soil depth
7. Attenuation potential of soil

Methodology: Quantitative ranking of factors; weighted summation yields a total score.

Result: Numerical value called Site Index Number (SIN). The larger the SIN, the greater the pollution potential of the groundwater at the site. The SIN value is related to a pollution potential category; categories range from "very high" to "low".

<u>SOI</u>: Soil Ratings for Pesticide Leaching and Surface Loss Potential.

Developed by: Iowa State University / Soil Conservation Service

Purpose:

1. To evaluate the relative potential loss of pesticides from soils due to leaching and surface runoff.
2. To serve as a screening tool to define zones where:
   a. Unacceptable losses occur regardless of management
   b. Unacceptable losses occur, but may be reduced to acceptable losses by management.
   c. Little losses occur regardless of management.

Factors used:

1. Hydrologic soil group
2. Organic matter of first soil horizon
3. Half-life time of pesticide
4. Organic carbon coefficient of pesticide
5. Soil erosion factor K

Methodology: Use of algorithms that were developed based on extensive computer simulations. Pollution category selection based on bench mark values.

Results:

a. Soil leaching potential ranging from "high" to "nominal".
b. Pesticide leaching potential ranging from "large" to "total use".
c. Soil surface loss potential ranging from "high" to "nominal".
d. Pesticide surface loss potential ranging from "large" to "small".

<u>Selection of a Screening Procedure</u>

Each of the three screening tools has its advantages and limitations. DRASTIC and SOI seem to reflect the backgrounds of their developers. All three methodologies exclude some factors that may play an important role in pesticide movement. However, especially when coupled with some steps external to the methodology, each screening procedure may lead to the identification of potentially hazardous sites.

In order to select a screening tool for this study, the following criteria are used:

1. Ease and rapidity of use while including factors important to pesticide movement;

2. Appropriateness for use at many different points in a large area; and

3. Ease with which results can be mapped.

DRASTIC is selected as the tool to be used because this methodology includes the influence factors "depth to groundwater" and "net recharge". The numerical results are conducive to point representation on large scale mapping.

SEEPPAGE represents soil influences on possible pesticide movement very well. However, the methodology is designed to be fairly situation and site specific. It uses the influence factor "distance to well". This factor is difficult to include in a statewide screening procedure. Furthermore, "distance to a well" does not address the problem of possible future use of the groundwater resource.

SOI is the only methodology that includes pesticide properties in the screening process. However, this study addresses the influence of chemical-physical properties on leaching in more detail subsequent to the screening process. Using only the soil component of SOI as screening procedure may not be sufficient.

Agricultural DRASTIC Index for Cropping Areas in Utah

Index Calculation

The agricultural DRASTIC index is the weighted sum of seven factors that might affect pesticide movement. The index is calculated as:

$$\text{Pollution Potential} = D_R*D_W+R_R*R_W+A_R*A_W+S_R*S_W+T_R*T_W+I_R*I_W*C_R*C_W \qquad (6)$$

Where: The subscript R stands for rating, the subscript W stands for weight

and:
D = Depth to groundwater
R = Net recharge
A = Aquifer media
S = Soil media
T = Topography (slope)
I = Impact of vadose zone
C = Hydraulic conductivity

The weights indicate the relative importance of each factor with respect to the other factors. Each DRASTIC factor has been assigned a relative weight ranging from 1 to 5. The most significant factors have the weight of 5; the least significant, a weight of 1. These weights are constants and may not be changed.

Each DRASTIC factor has a rating varying from 1 to 10. The highest pollution potential of a factor is expressed by the rating 10; the lowest by the rating 1; for example, a depth to the groundwater of 0 to 5 feet would yield the rating 10 whereas a depth to the groundwater of more than 100 feet would be linked to a rating of 1.

Weight and rating definition and selection are described in detail by Aller et. al. (1985). The interested reader is referred to this source of information. However, a word of caution needs to be spoken here: Two different DRASTIC indices exist, a general index and an agricultural index. The two indices differ in the weight selection. Results using the general index should not be compared to results using the agricultural index. This study uses the agricultural index.

DRASTIC Factor Information

As in almost any analysis, the quality of the pollution potential calculation depends on the quality of the input data. Input, in the case of the DRASTIC index calculation, is quantitative information concerning the DRASTIC factors. The quality of this information varies by region and county. Data comes from published sources supplemented by field information and best judgement. A brief discussion of DRASTIC factor information follows.

Depth to Groundwater. Depth to groundwater varies with time and location. At a given location, considerable fluctuations during a season and between seasons may be observed. In undulating terrain, spatial variation in depth to groundwater may be extremely pronounced.

Technical bulletins and basic data reports of the U.S. Geological Survey, 208 reports, and field information were used as information source. Some reports provide "depth to groundwater" mapping, whereas others list data on selected wells (including depth to water surface).

Net Recharge Rate. Net recharge rates depend on precipitation and irrigation. In most of Utah's agricultural areas, precipitation contributes 0 to 2 inches to net recharge. However, due to irrigation, total annual net recharge rates of ten exceed 10 inches (a value that yields the maximum DRASTIC rating). Therefore the selected efficiencies do not affect DRASTIC results. Table 9 indicates the net recharge selection.

Aquifer Media, Vadose Zone, Hydraulic Conductivity

Agriculture (especially irrigated agriculture) is mainly concentrated in valley floors and adjacent benches. Sediments of various granulometric

TABLE 9. Net Recharges Used in DRASTIC Calculation

Crop	ET	On-Farm Efficiency	Deep Percolation Loss	Winter Recharge	Total Net Recharge
Fruit Trees	37"	80%	9.3"	2"	11.3"
Corn	23"	70%	9.9"	2"	11.9"
Small Grains	22"	65%	11.8"	2"	13.8"
Alfalfa	30"	60%	20.0"	2"	22.0"
Vegetables (single crop)	15"	80%	3.8"	2"	5.8"
Vegetables (double crop)	30"	80%	7.6"	2"	9.6"
Potatoes	17"	80%	4.3"	2"	6.3"
Dry Farming				2"	2.0"

composition dominate in those areas. Some technical bulletins and basic data reports reveal information on aquifer media and hydraulic conductivity; however best judgement plays an important role in assessing the quantitative values for aquifer and vadose characteristics.

Soil Media. Soil is a well documented DRASTIC factor. Detailed soil surveys are available for many regions. Figure 4 shows the areas covered by modern published soil surveys in Utah. In addition, old soil surveys provide complementary information, and a general soil map (scale 1:1,000,000) provides an overview on soils in Utah.

Topography. Topography maps are available for the entire state.

Example Calculation for Utah County

Data from Utah County are used to demonstrate the DRASTIC procedure as used in this study. Based on information provided by the survey, cropping areas are mapped as shown in Figure 5. Table 10 shows the calculation of the agricultural

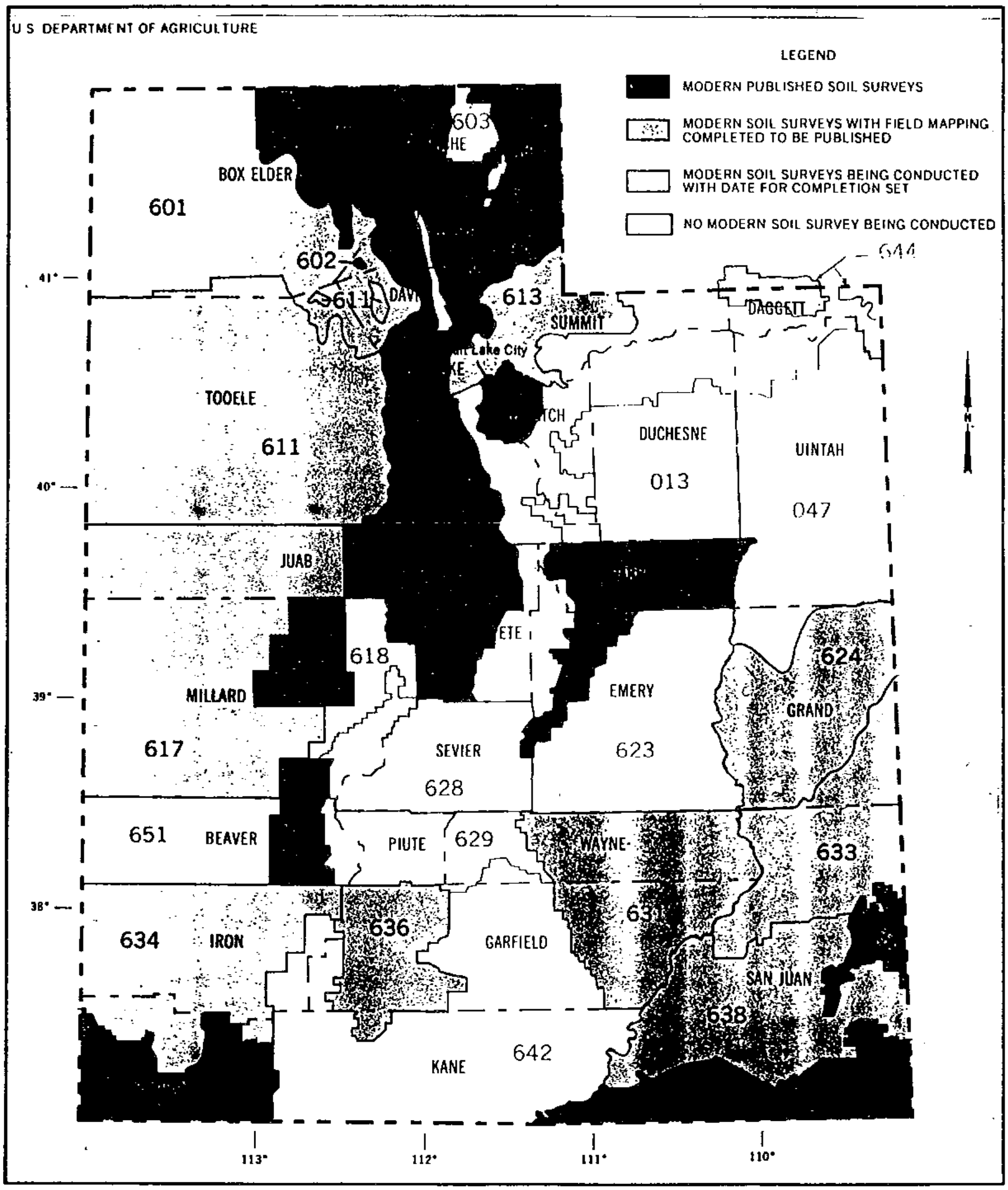


Figure 4. Areas Covered by Published Soil Surveys (Original Draft by State Soil Survey Staff).

DRASTIC index, and Figure 6 shows its geographical representation. Calculations in Table 10 are for the north-west part of Utah County's cropping area. The selection of the point density and point location is based on good judgement. Notice in the table the impact of low net recharge and large depth to groundwater.

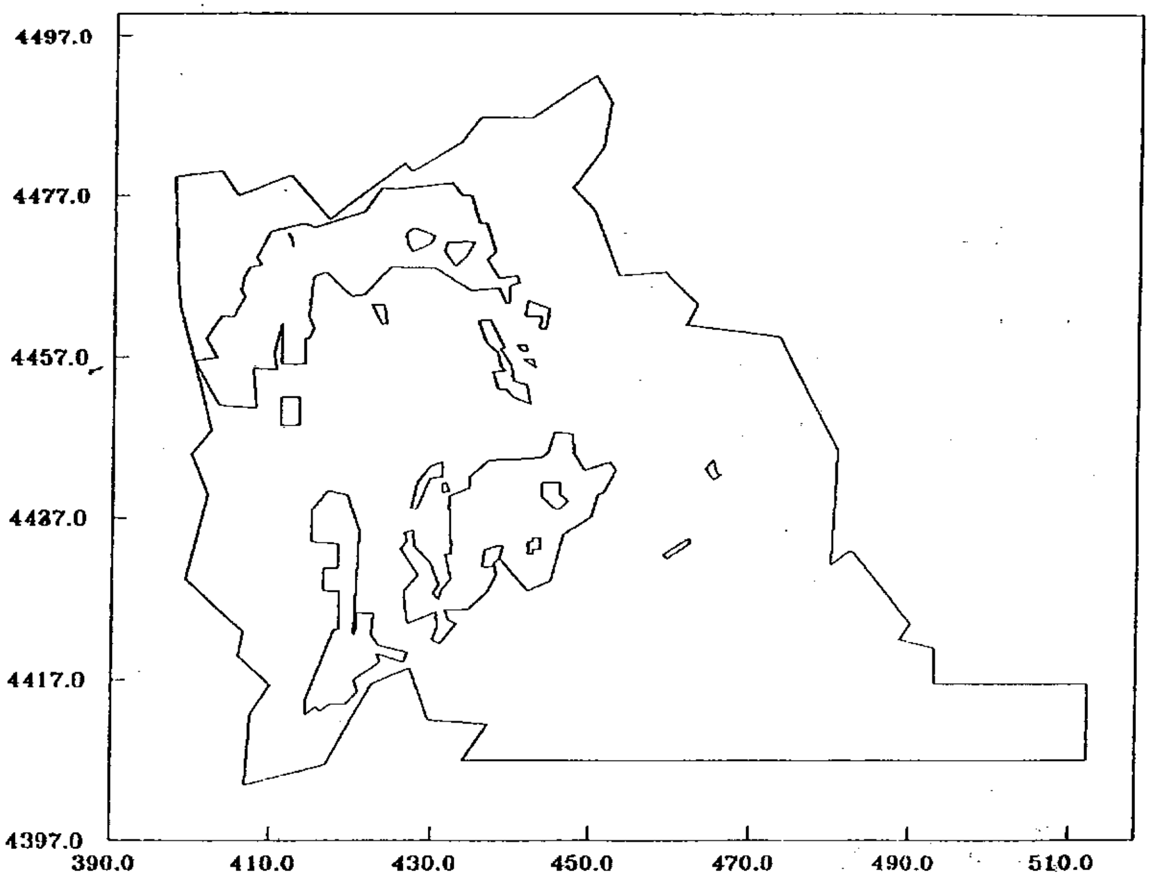


Figure 5. Cropping Areas in Utah County

TABLE 10. Agricultural DRASTIC Index for Utah County

No.	Coordinates X	Y	Depth (ft)	R	I	Net Recharge (In.)	R	I	Aquifer Media Type	R	I	Soil Media Type	R	I
1	411.0	4469.0	>100	1	5	2	1	4		6	18	SaL	6	30
2	408.0	4464.0	82	2	10	+10	9	36		6	18	L	5	25
3	406.0	4457.0	5	5	25	2	1	4		6	18	SaL	6	30
4	405.0	4453.0	80	2	10	2	1	4		6	18	SaL	6	30
5	413.0	4460.0	27	7	35	+10	9	36		6	18	SaL	6	30
6	409.0	4460.0	34	5	25	+10	9	36		6	18	SiL	4	20
7	418.0	4470.0	80	2	10	2	1	4		6	18	SiL	4	20
8	423.0	4473.0	80	2	10	+10	9	36		8	24	SiL	4	20
9	429.0	4469.0	18	7	35	+10	9	36		8	24	ScL	3	15
10	435.0	4472.0	10	9	45	+10	9	36		8	24	SiL	4	20
11	437.0	4466.0	16	7	35	+10	9	36		8	24	ScL	3	15
12	443.5	4462.7	20	7	35	+10	9	36		8	24	L	5	25

TABLE 10. Continued

Topography (%)	R	I	Vadose Zone Type	R	I	Conductivity (ft/d)	R	I	Total Index
2-4	8	24		6	24		4	8	113
2-4	8	24		6	24		4	8	145
2-5	7	21		6	24		4	8	130
2-5	7	21		6	24		4	8	115
2-5	7	21		6	24		4	8	172
0-2	10	30		6	24		4	8	161
2-4	8	24		6	24		4	8	108
1-3	9	27		6	24		4	8	149
1-3	9	27		6	24		4	8	169
1-3	9	27		6	24		4	8	184
1-3	9	27		6	24		4	8	169
1-3	9	27		6	24		4	8	179

R = Rating I = Index

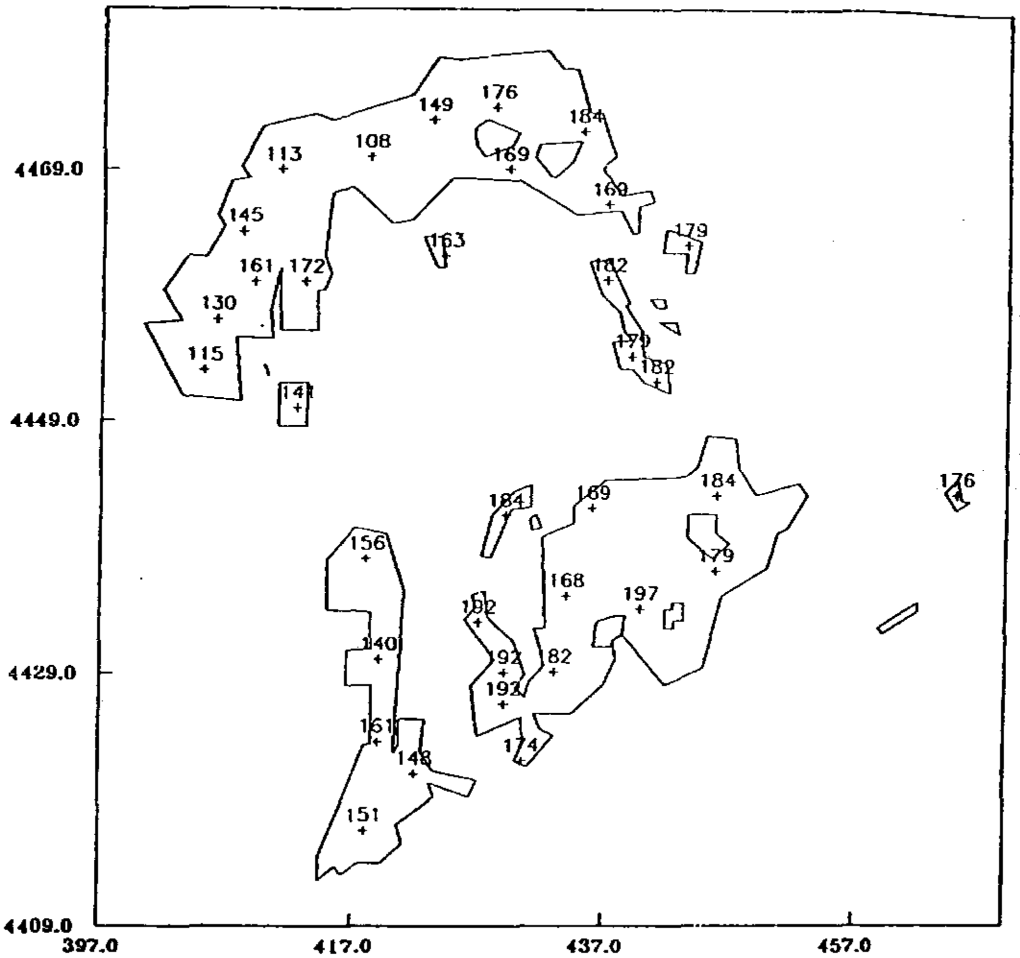


Figure 6. Agricultural DRASTIC Index for Utah County

Results of Statewide Screening

The results of the statewide screening for potential hazard to groundwater and map of cropping patterns are represented in Plates 1 and 2. Table 11 gives the lowest, highest and average agricultural DRASTIC value for each county.

Each value in the plate expresses the DRASTIC result for a particular point. To address the vulnerability of a spatially extended area, average index values over several points may be formulated. It generally holds true that the larger the number of points included in the averaging process, the larger the spacial extent of the area. One may attempt to formulate criteria on how many points should be included in the averaging processes, or what size of a sub-area should be analyzed for its potential vulnerability. However, no clear cut point number - area relationship is presented here. In this study, DRASTIC index locations are selected by an expert mind, and not by a pre-determined grid system. Averaging over too many points might disguise some problem areas (if very low values are included in the average). Averaging over too few points might not provide an indication for the spatial extent of the problem. Table 11 indicates for each county the minimum and maximum DRASTIC index, the number of points N analyzed in a county and average values including 5 points, 10 points, 15 points, 20 points, and all points of a county. Table 11 allows the following ranking of counties:

Highest Values: (>200)	Wayne, Daggett, Duchesne, Weber, Cache, Kane, Summit, Unitah.
Lowest Values: (<110)	Box Elder, Cache, Millard, Utah.
Highest 5 Point: (>190)	Wayne, Weber, Duchesne, Cache, Davis, Summit, Utah, Uintah.
Highest 10 Point: (>185)	Weber, Wayne, Cache, Davis, Utah, Wasatch,Duchesne, Summit, Juab.
Highest 15 Point: (>180)	Weber, Cache, Wasatch, Utah, Sanpete, Duchesne
Highest 20 Point: (>180)	Weber, Wasatch, Cache, Utah

Total averages are not ranked, since a five point average in Daggett county would be compared to a 72 point average in Box Elder County.

TABLE 11. Range and Average Agricultural DRASTIC Values for Each County

County	Min.	Max.	5Pt.	10Pt.	15 Pt.	20Pt.	tot.ave.	N
Beaver	147	178	176.4	173.2	164.5	168.3	165.4	21
Box Elder	87	189	184.4	178.5	173.7	169.6	136.88	72
Cache	102	202	198.8	191.9	187.3	182.6	164.3	32
Carbon	162	184	175	-	-	-	171.0	8
Daggett	165	207	185.6	-	-	-	185.6	5
Davis	170	196	195	189.4	-	-	184.5	12
Duchesne	155	203	199.4	187.9	180.7	175.2	173.4	22
Emery	143	183	177	168	162	-	160.8	16
Garfield	134	187	178.2	164.2	-	-	158	13
Grand	163	188	178.8	176.2	-	-	173.2	14
Iron	138	183	179	174	170.6	165.6	163.2	22
Juab	129	196	186.8	182.2	179.4	172.6	158.8	33
Kane	145	202	187.6	177.6	-	-	169.6	14
Millard	107	175	169.4	165.2	162.7	158.5	146.5	31
Morgan	125	197	182.2	196.0	-	-	165.0	13
Piute	152	188	184.8	180	-	-	175.3	14
Rich	142	194	184.9	181.1	176.3	-	172.3	17
Salt Lake	143	188	182.6	178.6	173.9	-	169.5	19
San Juan	130	181	169	161	158	-	150.8	20
Sanpete	137	194	188.6	196.1	182.5	178.8	173.8	25
Sevier	153	199	189.4	183.1	-	-	177	14
Summit	148	201	192.2	185.8	178.5	173.6	169.1	28
Toole	155	194	186.4	181.6	-	-	174.4	15
Uintah	123	200	190	183.9	179.6	173.6	162	32
Utah	108	197	191.4	189.1	184	180.5	164.6	35
Wasatch	158	188	188	188	186.7	185.2	174.2	44
Washington	161	194	188.8	181.8	-	-	177.7	13
Wayne	146	209	202.4	195.8	-	187.3	183.7	17
Weber	180	203	201.6	198	195.1	192.7	192.1	21

The developers of the DRASTIC procedure emphasize that DRASTIC indices are relative values that should only be used for comparison purposes. Aller et al., (1985) do not link DRASTIC score to a descriptive statement about the pollution potential.

One may notice that indices represented in Plate 1 are generally rather high. However, the analysis in this study focuses only on agricultural areas. In these areas, net recharge to groundwater is strongly influenced by irrigation, and groundwater is often close to the surface. An agricultural DRASTIC calculation outside of agricultural areas (notice the apparent contradiction in this formulation) would in most cases result in rather low scores.

COMPUTER SIMULATION OF PESTICIDE MOVEMENT

The agricultural DRASTIC procedure described in the previous chapter identifies cropping areas in Utah, in which the application of pesticides may pose a potential hazard to groundwater quality. In those areas, further investigation, using a pesticide transport model, is required.

Simulation Models

In many studies, considerable effort needs to be devoted to the selection of an appropriate model. Wood (1984) expresses the model selection problem in the following way:

> "On one hand, a high level of complexity requires a sizeable number of rate coefficients and mathematical descriptions of transformation processes, which must be identified on the basis of a limited amount of knowledge. On the other hand, a simplified model, although requiring very few parameters, may give a poor conceptual view of the system and add little insight into the pertinent process."

Three models were considered for use in this study. A short description of the models follows.

Chemical Movement in Layered Soil (CMLS). CMLS is a management model that can be used to make decisions regarding the behavior of agrichemicals in soils. The model estimates the location of the peak concentration of non-polar organic chemicals as they move through a soil in response to downward movement of water. The model also estimates the relative amount of each chemical still remaining in the soil at any time. CMLS is developed by Nofziger and Hornsby (1986).

Pesticide Root Zone Model (PRZM). PRZM was originally developed to be used in EPA's pesticide registration program. The model simulates the vertical movement of pesticides in unsaturated soil, within and below the plant root zone, and extending to the water table. It uses generally available input data that are reasonable in spatial and temporal requirements. The model consists of hydrology and chemical transport components that simulate runoff, erosion, plant uptake, leaching, decay, foliar washoff, and volatilization of pesticide. PRZM is developed by Carsel et. al. (1984).

Groundwater loading and Erosion from Agricultural Management Systems (GLEAMS). GLEAMS was developed for field-size areas. The model evaluates effects of agricultural management systems on the movement of agricultural chemicals within and through the plant root zone. GLEAMS is an extension of the USDA CREAMS model. The model was developed for the USDA by Leonard et al., (1987).

Model Selection

The PRZM and the GLEAMS model were compared. Both models seemed to perform about equally well. However, for both models input value development is rather cumbersome and not conducive to the rapid analysis of a great number of different cases. It was therefore decided to: (a) prefer PRZM over GLEAMS and (b) to develop a user-friendly, interactive interface for the PRZM model. By means of this interface, the PRZM and the CMLS model are about on the same level of user-computer interaction, and can easily be composed. The following comparison criteria are used:

1. Accuracy in the prediction of pesticide movement;
2. Simulation time requirement;

3. Input value requirement; and

4. Accessibility of model output.

Both models have undergone limited performance testing; the PRZM model in New York, Wisconsin, Florida and Georgia; the CMLS model mainly in Florida. The PRZM model permits more parameter input values, however, an increased number of parameters does not necessarily increase adequacy.

Advantages of the CMLS model include the following, The mathematical solution used in the CMLS model is less complex than the one used in the PRZM model. Consequently, the simulation time requirement is much smaller when using the CMLS model (especially when simulating pesticide movement to depths of several meters). The CMLS model requires fewer input values. Pesticide and soil data are stored in a data base and are retrievable by name (an important feature in case of extensive, repeated simulation). The CMLS model displays results on the screen. Printing screens with selected output values permits one to avoid extensive file-keeping for later analysis.

Both models were used to simulate the movement of the insecticide carbofuran in Martini soil in Weber County (pesticide application: 1.12 kg/ha). Concentrations predicted by both models were very close.

The CMLS model was judged to be the appropriate tool to achieve the objective of this study which is to compare the potential hazard at various sites throughout Utah. However, it should be noted that the CMLS model might overpredict the movement of polar pesticide into soils with a higher cation exchange capacity.

Basic Concepts and Assumptions Used in the CMLS Model

The CMLS model integrates two basic concepts: (a) the movement of the chemical; and (b) the degradation of the chemical. In this model, chemicals move only in the liquid phase in response to soil-water movement. Water movement is calculated using a volume balance approach. Chemicals are exposed to adsorption processes and therefore advance in depth less far than water. A linear and reversible equilibrium adsorption model simulates the retardation of the chemical movement. The following equations are used to predict chemical movement:

$$dd_s = \frac{q}{R * T_{FC}} \tag{7}$$

$$R = 1 + \frac{BD * K_D}{T_{FC}} \tag{8}$$

$$K_D = K_{OC} * OC \tag{9}$$

where:

- dd_s = Change in depth of the solute
- q = Amount of water passing the depth d_s
- d_s = Depth of the solute front in a uniform soil
- R = Retardation factor
- T_{FC} = Soil-water content on a volume basis at field capacity
- BD = Soil Bulk Density
- K_D = Partition coefficient of the chemical in soil
- K_{OC} = Organic carbon partition coefficient
- OC = Organic carbon content of the soil

Chemicals are exposed to degradation processes. The model predicts the fraction F of the applied chemical remaining in the entire soil profile as:

$$F = \exp(-t * \frac{\ln(2)}{t_{1/2}}) \tag{10}$$

where: t = Elapsed time since the chemical was applied

$t_{1/2}$ = Biological degradation half-life of the chemical

Pesticide movement predictions given by the CMLS model are based on the following assumptions (Nofziger and Hornsby, 1986):

1. All soil water residing in pore spaces participates in the transportation process. If this assumption is not valid and a portion of the soil water is bypassed during flow, the model underestimates the depth of the chemical front;
2. Water entering the soil redistributes instantaneously to field capacity;
3. Root distribution is uniform with depth;
4. Upward movement of soil-water does not occur;
5. The adsorption process can be described by a linear, reversible equilibrium model; and
6. The half-life time for biological degradation is constant with time and soil depth.

Further explanations of these concepts and the user interaction of the CMLS model are given by Nofziger and Hornsby (1986 and 1988).

DATA PREPARATION

The CMLS model requires data on precipitation, evapo-transpiration, crop rooting depth, pesticide, soil, and pesticide application. Considerable effort has been devoted to the collection and preparation of these data.

Climate Data and Time Window Selection Climate Data

Utah is divided into zones of more or less uniform climate. The zonal boundaries are shown in Figure 7.

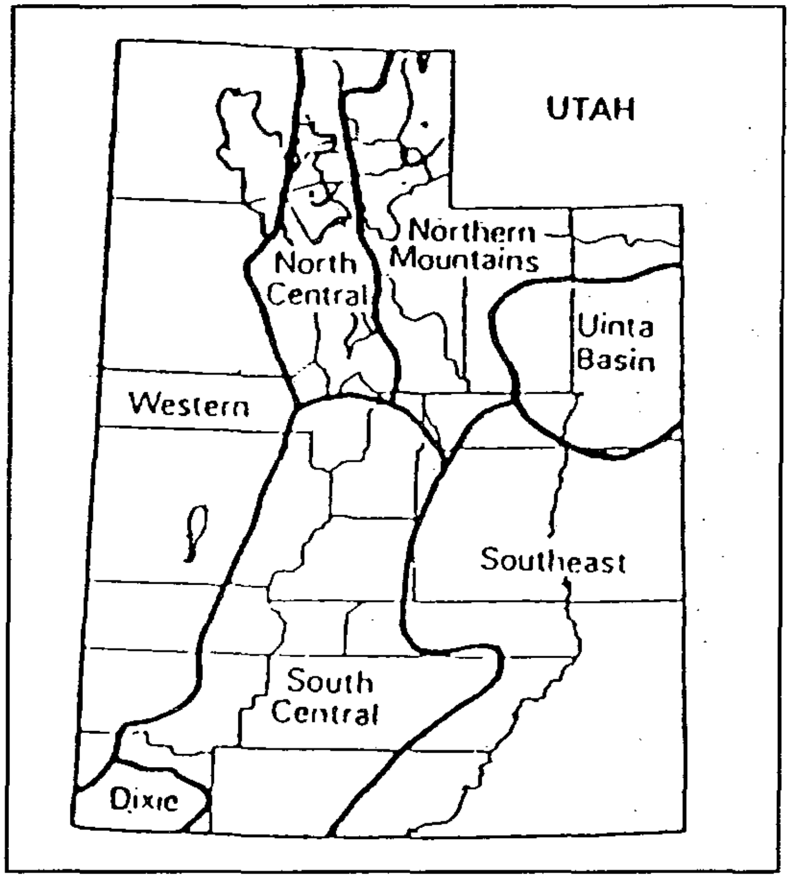


Figure 7. Zones of Relatively Uniform Climate Conditions.

For each zone, a weather station was selected based on recommendations of the State Climatologist (personal communication G. Ashcroft, 1989). It is assumed that this station provides representative data for the entire zone. Table 12 gives an overview of zones, counties in a zone, and representative weather stations.

TABLE 12. Zone, County, Weather Station Assignment

Zone	Counties	Weather Station
North Central	Box Elder Cache Weber Davis Salt Lake Utah	Ogden Sugar Factory
North West	Juab Tooele	Park Valley
Northern Mountains	Rich Morgan Summit Daggett Wasatch	Randolph
Uintah Basin	Uintah Duchesne	Fort Duchesne
South Western	Millard Beaver Iron	Delta
Dixie	Washington	St. George
South Central	SanPete Sevier Piute Wayne Garfield Kane	Richfield Radio KSVC
Southeast	Carbon Emery Grand San Juan	La Sal

Daily data on precipitation, pan evaporation (if available), maximum and minimum temperature were obtained from the State Climatologist for the weather stations indicated in Table 12.

Time Window Selection

Pesticide movement is directly related to precipitation, however, precipitation varies considerably within and between seasons. An analysis of Ogden precipitation data from 1928 through 1986 reveals a seasonal minimum of 21.0 cm in 1966 and a seasonal maximum of 87.1 cm in 1983.

Weather data series provided by the State Climatologist vary considerably in length: Ogden Sugar Factory data cover the period from 1928 through 1986 whereas La Sal data cover only the period from 1978 through 1988.

In order to compare results throughout the state, pesticide movement should be analyzed at all locations for the same time period. To select an appropriate time period, we assume that after a six year period, based on a single application, movements of currently registered pesticides are below the technical limits of any detection equipment. Therefore, the maximum time window, for analyzing the movement of a single pesticide application, should not exceed six years.

Ogden Sugar Factory weather data are analyzed for the probability of exceeding certain seasonal rainfall. Results for the years 1980 through 1986 are shown in Table 13. The probability of an exceedance of 0.53 in 1981 means that about every second year, the seasonal total precipitation of 1981 is exceeded.

TABLE 13. Probability of Exceedance of Seasonal Rainfall

Year	Probability
1980	0.09
1981	0.53
1982	0.07
1983	0.02
1984	0.32
1985	0.77
1986	0.11

The probability of exceedance of the sum of:

a. Two seasons in a row starting in 1980 is 0.16;

b. Three seasons in a row starting in 1980 is 0.11;

c. Four seasons in a row starting in 1980 is 0.02;

d. Five seasons in a row starting in 1980 is 0.02.

However, major pesticide movement usually occurs during the first two years after application.

This study analyzes pesticide movement using climate data from 1980 through 1985. Results of the probability analysis indicate that this is a rather conservative choice. Analysis of a "dryer" time window would result in less pesticide movement. However, one must recognize the possibly important influence of irrigation. Seasonal irrigation applications usually exceed seasonal precipitation.

Evapo-Transpiration Data

Extensive research is conducted in the field of evapo-transpiration (ET), and numerous equations to calculate evapo-transpiration are presented in the literature. Hargreaves and Samani (1985) developed an approach that requires only data on minimum and maximum temperature and information on the latitude of the location. Samani and Pessarkli (1986) have shown good accordance between real ET_p and calculated ET_p using the Hargreaves - Samani equation. For Utah, the equation for daily ET_p calculations may be formulated as:

$$ET_p = 0.0023 * R_A * TD^{1/2} * (TC + 17.8) \quad (11)$$

$$ET_{crop} = K_c * ET_p \quad (12)$$

Where: ET_p = Potential ET of alfalfa (mm)

R_A = Extraterrestrial radiation (mm)

TD = Temperature difference $T_{max} - T_{min}$ (C°)

TC = Average daily temperature (C°)

ET_{crop} = Evapotranspiration of a given crop (mm)

K_c = Crop coefficient

Extraterrestrial radiation may be expressed as a function of latitude. The interested reader is referred to Hargreaves and Samani (1985). Hill et. al. (1987) calculated K_c values for the Bear River drainage basin (Utah, Wyoming, Idaho). Based on his results, the K_c values indicated in Table 14 were used throughout the entire state.

One may argue that crop coefficients developed for northern Utah should not be used in the southern part of the state. However, the data in Table 14 are to our knowledge, the best available. Using questionable old data sets for the southern part of Utah was judged to be inappropriate.

<u>Irrigation Data</u>

Irrigation plays an important role in Utah's agriculture. Part of the irrigation water is lost to deep percolation, and contributes in a significant way to pesticide movement. Deep percolation and surface runoff loss

TABLE 14. Crop Coefficients

Crop	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Alfalfa	0.00	0.00	0.27	0.60	1.03	1.03	0.83	0.89	0.92	0.36	0.00	0.00
Spring Wheat	0.00	0.00	0.18	0.25	0.55	1.12	1.14	0.12	0.12	0.12	0.00	0.00
Winter Wheat	0.00	0.00	0.27	0.66	1.19	1.20	0.40	0.12	0.12	0.12	0.00	0.00
Corn	0.00	0.00	0.18	0.25	0.24	0.43	0.95	1.12	0.71	0.30	0.00	0.00
Vegetables	0.00	0.00	0.18	0.25	0.26	0.79	1.14	1.09	0.66	0.24	0.00	0.00
Potatoes, Onions	0.00	0.00	0.18	0.25	0.24	0.69	0.88	0.81	0.40	0.24	0.00	0.00
Orchards	0.00	0.00	0.25	0.37	0.71	0.97	1.02	1.08	0.97	0.87	0.00	0.00

are implicitly expressed in the on-farm application efficiency, which may be defined for a single irrigation event as:

$$E_a = \frac{V_s}{V_a} \tag{13}$$

where: E_a = On farm application efficiency

V_s = Total volume stored in root zone

V_a = Total volume applied

Table 15 shows data on on-farm application efficiencies. For the purpose of this study, on-farm irrigation efficiencies (considering only water stored in the root zone and water lost to deep percolation) are 50%, independent of field application systems. Actual efficiencies may be better or worse, depending on location and field application method. Fifty percent is considered to be a conservative estimate.

The zones shown in Figure 7 are used as zones of uniform irrigation water requirement. Seasonal net irrigation water requirement is calculated as the average difference between crop evapotranspiration and precipitation during the cropping period. The average seasonal irrigation application is assumed equal to the net requirement divided by the application efficiency. Table 16 indicates the total seasonal irrigation applications per irrigation zone based on a 50% application efficiency.

TABLE 15. On-Farm Application Efficiencies (Source.: Utah Department of Health, 1986).

COUNTY	Overall Irrigation Efficiency (Percent)	Onfarm Irrigation Efficiency (Percent)	Delivery System Efficiency (Percent)	Acres Irrigated Wells (1000's)	Acres in Group Systems (1000's)	Acres Irrigated Total (1000's)
BEAVER	32	42	76	8	20	28
BOX ELDER	23	28	82	30	87	117
CACHE	26	30	87	0	101	101
CARBON	24	29	82	0	14	14
DAGGETT	21	28	75	0	10	10
DAVIS	30	35	85	0	32	32
DUCHESNE	26	33	80	0	72	72
EMERY	26	30	85	0	37	37
GARFIELD	20	38	80	0	25	25
GRAND	30	35	85	1	3	4
IRON	32	38	84	31	17	48
JUAB	31	40	78	4	24	28
KANE	30	46	65	4	4	8
MILLARD	36	40	89	8	92	100
MORGAN	26	33	79	2	9	11
PIUTE	25	32	77	8	16	24
RICH	21	28	75	0	48	48
SALT LAKE	30	35	85	0	43	43
SAN JUAN	24	30	80	1	7	8
SANPETE	28	33	85	0	82	82
SEVIER	28	33	85	7	52	59
SUMMIT	24	30	80	17	23	40
TOOELE	25	32	78	7	11	18
UINTAH	26	33	80	6	73	79
UTAH	36	42	85	10	90	100
WASATCH	26	34	76	6	21	27
WASHINGTON	35	44	80	0	18	18
WAYNE	30	36	83	8	13	21
WEBER	30	38	8	0	44	44
STATE	28	37	80	158	1088	1246
	Weighted Average	Weighted Average	Straight Average			

Source: Utah Department of Agriculture Irrigation Statistics

TABLE 16. Seasonal Irrigation Applications in Centimeters

Zone	Alfalfa	Corn	Wheat	Vegetables	Potatoes, Onions	Orchards
North Central	120	115	64	100	75	140
Northern Mountains	120	115	64	100	75	140
Uintah Basin	150	130	100	130	90	160
South Central	140	120	90	120	90	160
South East	130	105	70	100	100	140
South West	150	130	100	140	100	170
Dixie	200	140	120	160	120	160

Pesticide Data

Two pesticide dependent values are related to pesticide movement and degradation in soil: the organic carbon partition coefficient (K_{oc}) used to predict absorption processes, and the half-life time ($t_{1/2}$) used to calculate degradation processes. The data used in this study are based on "materials from the water quality workshop presented in Fort Worth, Texas" (1988) by the Soil Conservation Service and the Extension Service. Note that different sources provide different K_{oc} and $t_{1/2}$ values for the same pesticide. Appendix C gives an alphabetical listing by common name of all pesticides analyzed in this study. Table 17 shows an example of this listing.

TABLE 17. Pesticide Data

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:ALACHLOR	H	1.5
Partition Coefficient	:190 mg/g OC		
Half-Life	:14 days		
Trade Name	:ALANEX		
Trade Name	:PILLARZO		
Trade Name	:LASSO		
Trade Name	:.		

Soil Data

The soil influences adsorption and water movement processes. Organic carbon affects adsorption. Volumetric water content, field capacity, wilting point, bulk density and saturation affect water movement. Generally, values vary by layer. Table 18 shows soil data for the example of a Hillfield soil.

TABLE 18. Example of Soil Data

Soil Name : HILLFIELD   Identifier : UT0394

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.08	2.48	1.44	23.0	11.0	41.2
2	0.25	1.77	1.44	23.0	11.0	41.2
3	0.46	1.03	1.45	22.0	10.0	41.2
4	0.79	0.65	1.35	25.0	12.0	41.2
5	1.27	0.20	1.45	18.0	8.0	41.2
6	1.63	0.10	1.45	18.0	8.0	41.2

A complete listing (in alphabetical order of soil name) used in this study is given in Appendix D.

Modern soil surveys provide the data required. However, as of today, only about 25% of Utah is covered by published surveys. Figure 4 shows the areas for which modern soil surveys are presently available. Soil data on unpublished surveys are found with the SCS. These data, a soil map 1:1,000,000 (Wilson et al., 1975), and old surveys are also used in this study.

Rooting Depth Data

Through their rooting system crops extract water and pesticide from the soil profile and reduce downward movement of the chemical. Rooting depths depend on many factors, may be site specific, and vary from season to season. However, in this study, rooting depth is treated as a site independent, constant value. Table 19 gives an overview of the rooting depths used.

TABLE 19. Rooting Depths

Crop	Rooting Depth in Meters
Alfalfa	1.50
Corn	0.90
Small Grains	1.10
Onions	0.30
Potatoes	0.80
Vegetables	0.60
Trees	1.20

Soil Incorporation Data

Pesticide adsorption processes are directly dependent on the organic carbon content of the soil. Generally, the organic carbon content is highest in the top layer of a soil. Incorporation (application) of a pesticide below this layer may result in increased leaching. However, certain pesticides need to be incorporated in order to reach their target. Pesticide incorporation data are given in the original survey response provided by extension agents.

COMPUTER SIMULATION OF PESTICIDE MOVEMENT

Site Identification

The agricultural DRASTIC procedure identifies areas that based on their hydro-geological setting (depth to groundwater, recharge rate, slope, soil and geological properties), may be vulnerable to groundwater contamination. However, contamination does not necessarily have to occur in these areas. Much depends on the agricultural practices in general, and the pesticide and its application in particular.

Figure 8 shows for each county the location of elevated potential hazard to groundwater. For each of these locations extensive computer simulation analysis is undertaken.

Model Application

Using the CMLS model, the site-specific movement of pesticides identified in the survey (Appendix B) is calculated. A sample analysis is demonstrated here. The insecticide diazinon is applied to corn on Vineyard soil. The application is in the month of may. Figure 9 shows the insecticide movement in soil, and irrigation and precipitation events for approximately six years.

For this site, Table 20 indicates traveling times (in days after application) to depth of 1.0 m, 1.5 m, 2.0 m, and 3.0 m, and the relative amount of pesticide remaining in the soil profile at that time. The absolute amount remaining in the soil profile is calculated as the relative amount times the initial pesticide application.

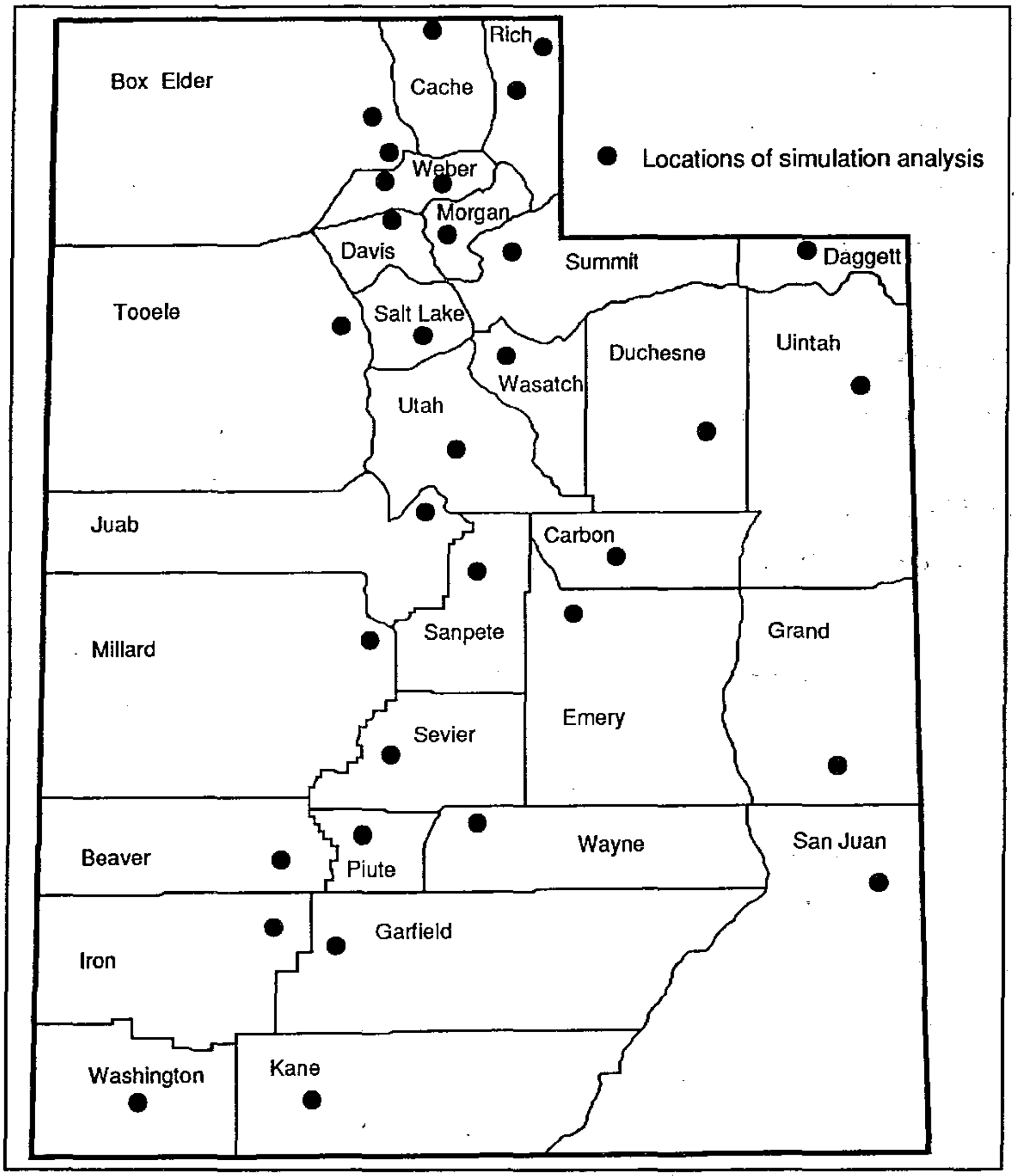


Figure 8. Computer Simulation Site Identification

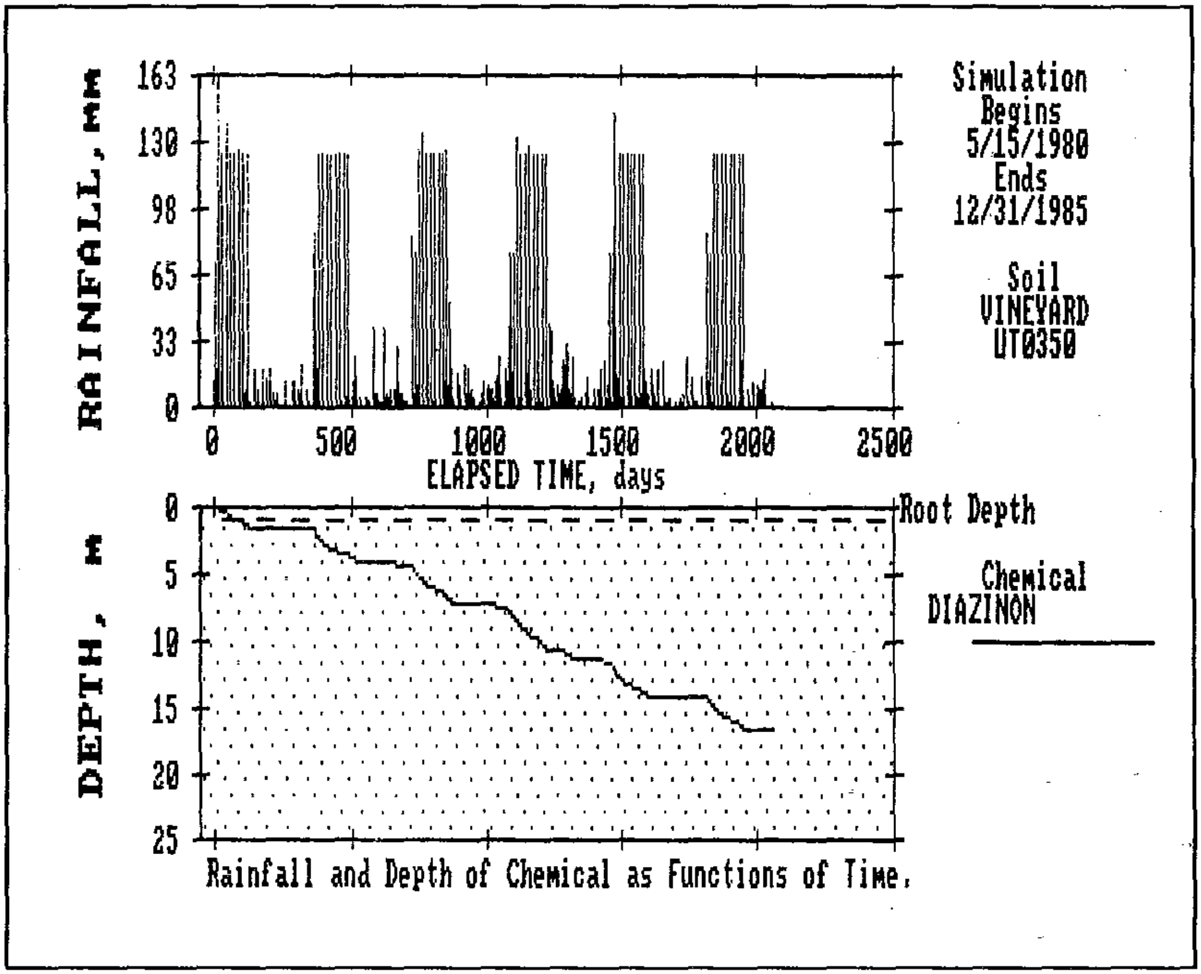


Figure 9. Water Application and Pesticide Movement

The CMLS model allows data output only for four preselected depths per run. If pesticide movement to a depth of 3.0 m is significant, an additional analysis with preselected depths of 5.0 m, 10.0 m, 15.0 m, and 20.0 m is undertaken. The interpretation of the simulation results includes the most likely depth to

groundwater. However, the selection of data output depth is independent of distance to groundwater. The adoption of this concept is based on the fact that

TABLE 20. Pesticide Movement to Selected Depths.

Chemical	DIAZINON
Partition Coefficient, Koc, (ml/g OC)	85
Application date, (month/day/year)	5/15/80
Ending date, (month/day/year)	12/31/85
Application depth, (m)	0.00
Rooting depth, (m)	0.90
Time (days) to 1.00 m	92
Relative Amount Remaining	0.1194
Time (days) to 1.50 m	316
Relative Amount Remaining	0.0007
Time (days) to 2.00 m	371
Relative Amount Remaining	0.0002
Time (days) to 3.00 m	426
Relative Amount Remaining	5.3E-005

depth to groundwater is often subject to important spatial and temporal variation.

A comprehensive overview on pesticide movement simulations is given in Appendix A.

Relation to Health Standards

Pesticide movement predictions are expressed in relative or absolute amounts of pesticide remaining in the unsaturated soil profile. Amounts are expressed in kilograms per hectare, whereas health standards, as listed in Table 4, are in parts per billion. To crudely convert absolute amounts in the unsaturated zone to parts per billion, one must assume that: 1- whatever mass of pesticide reaches some specified unsaturated depth in the soil will also reach ground water beneath saturated capillary zone at the same depth, without further reduction in mass; 2- pesticide will mix uniformly in the aquifer to some assumed depth of water; and 3- there is insignificant lateral movement of the ground water. The assumptions are necessary because CMLS computes movement of the pesticide only in the unsaturated zone. Assuming a mixing depth of one decimeter of water, the following conversion holds true:

$$1 \text{ kg/ha} = 10^3 \text{ ppb} \tag{14}$$

Although this approach gives high estimates of concentrations, it is useful for relative comparisons. In this approach if the porosity of the aquifer material is 0.3, the mixing depth of the pesticide is (1 dm)/0.3=3.33 dm, if the porosity is 0.003, this is 333.3 dm. Currently, 38 EPA suggested health standards are available to the authors of this study. Pesticide concentrations in the top layer of groundwater are compared to these standards and a ratio is calculated as:

$$\text{Ratio}_{\text{Depth}} = \frac{\text{Concentration of Pesticide}}{\text{Health Standard}} \tag{15}$$

Table 21 shows an extract of Appendix A. The chemical carbofuran is analyzed for a site in Carbon County.

TABLE 21. Health Standard Ratio

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Corn	Diazinon/ Dianon	1.12	1.0	92	.1194	134	0.63	212
			1.5	316	.0007	0.8		1.2
			2.0	371	.0002	0.2		0.4
			3.0	426	5.3E-5	0.1		0.1

Notice that the pesticide reaches the depth of one meter after 92 days, and that at this time the concentration of the pesticide computed via the crude approach described above in ground water is 134 ppb. This amount is about 212 times higher than the health advisory. Notice also that the pesticide reaches a depth of three meters after 426 days movement through the unsaturated zone. At this time the estimated concentration is far below the limit set by the health advisory. Thus the concentration in ground water that will result is very dependant on the depth to ground water.

Sensitivity of Results

The CMLS model's prediction of chemical movement is based on such parameters as:

a.	Chemical properties:	Carbon partition coefficient, half-life time;
b.	Soil properties:	Depth of soil layer, organic carbon content, bulk density, water content at different matric potentials;
c.	Evapotranspiration:	Temperature;
d.	Irrigation:	Volume, frequency;
e.	Pesticide application:	Quantity, date, soil incorporation; and
f.	Rooting depth:	Vertical crop root depth.

All parameters are treated as constants. However, most parameters depend on an array of influences and are variable in time and space. The influence of parameter fluctuation on pesticide movement is demonstrated for the examples of organic carbon partition coefficient, half-life time and irrigation.

Organic Carbon Partition Coefficient. The literature contains a large range of values for the organic carbon partition coefficient K_{oc}. Figure 10

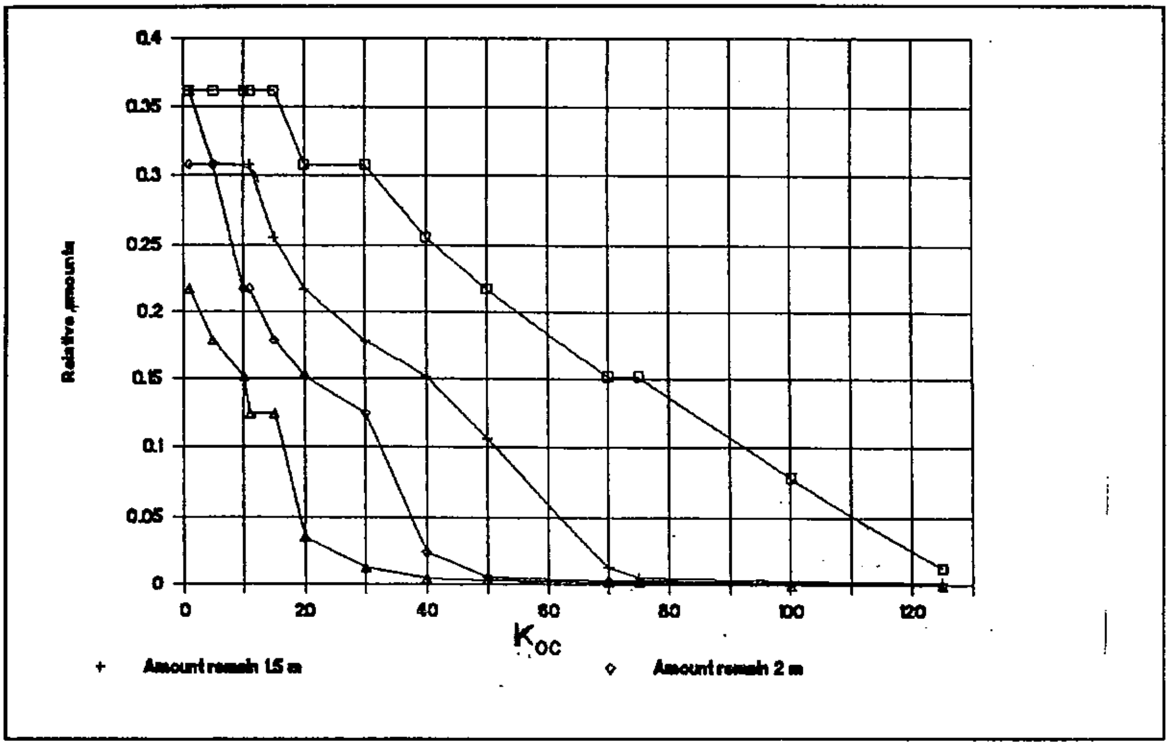


Figure 10. Sensitivity to values of K_{oc}

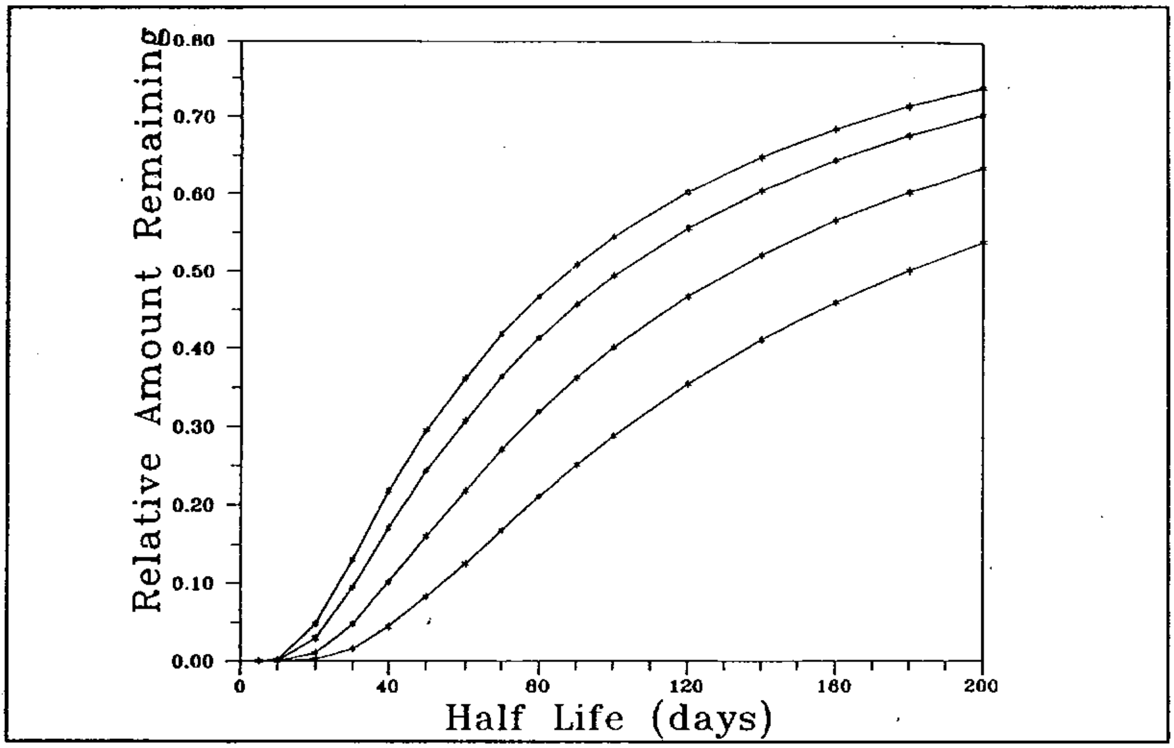


Figure 11. Sensitivity to values of $t_{1/2}$

shows pesticide movement to a depth of 1.0 m, 1.5 m, 2.0 m, and 3.0 m in response to different K_{oc} - values.

Results in Figure 10 reflect light textured soil conditions (martini soil in Weber County), and a constant pesticide half-life time of (curves are from top to bottom, respectively) 60 days (as for hexazinone).

Half-Life Time. Similar to K_{oc}, research studies indicate a large range of half-life time ($t_{1/2}$) values for a given pesticide. Figure 11 shows pesticide movement to a depth of 1.0 m, 1.5 m, 2.0 m, and 3.0 m in response to different $t_{1/2}$ values. Results in Figure 11 reflect the same soil conditions as in Figure 10, (curves are from top to bottom respectively) a constant K_{oc} of 11 (as for hexazinone).

Interpretation. Current analysis of pesticide movement is based on parameter estimates that are not always as accurate as desired. For certain pesticide - site combinations movement is highly sensitive to parameters such as k_{oc}, $t_{1/2}$, and irrigation. Therefore, it is not likely that field measurements will correspond exactly with model-predicted pesticide movement. However, results of a simulation study may very well be used for relative comparisons of pesticide application sites and pesticides used at these sites.

RESULTS OF THE SIMULATION ANALYSIS

Overview and Ranking of Concerns

A comprehensive listing of predicted pesticide movement is given in Appendix A. Table 22 summarizes, in alphabetical order, site/location - pesticide combinations that should attract increased concern. The results in the table are expressed as a ratio of pesticide concentration over health

TABLE 22. Critical Area - Pesticide Combinations

Site/County (Likely Depth to groundwater)	Pesticide	Computed Concentration/Health Standard or ppb at depths of 1.0m	1.5m	2.0m	3.0m	5.0m
25[1]/Beaver (D=3.0)	Carbofuran	14.2	10.9	7.9	4.4	-
	Hexazinone	1.9	1.6	1.4	1.0	-
	Atrazine	8.8	5.5	2.7	0.1	-
4/Box Elder (D=3.0m)	Carbofuran	6.6	1.6	-	-	-
	Atrazine	3.6	-	-	-	-
	Oxydemeton-Methyl	46.2ppb	0.01ppb	-	-	-
1/Cache (D=2.4m)	Carbofuran	3.1	2.6	2.1	-	-
	Hexazinone	1.0	0.9	0.9	0.7	-
	Metribuzin	0.1	0.1	0.1	-	-
	2,4-D	2.7	2.7	1.4	-	-
	Dicamba	12.1	4.3	4.3	1.9	-
	Alachlor	2.2	-	-	-	-
	Atrazine	214.0	128.0	8.2	5.4	0.22
	Metolachlor	3.6	-	-	-	-
	Cyanazine	3.6	1.2	-	-	-
	Metsulfuron	3.0ppb	2.7ppb	2.5ppb	0.4ppb	-
	Chlorsulfuron	12.0ppb	12.0ppb	7.4ppb	5.1ppb	-
	Phorate	0.4ppb	0.1ppb	-	-	-
	EPTC	0.5ppb	-	-	-	-
20/Carbon (D=3.6m)	Carbofuran	9.0	5.1	3.7	-	-
	Dicamba	3.5	1.8	-	-	-
13/Daggett (D=2.0m)						
8/Davis (D=1.5m)	Carbofuran	4.5	0.1	-	-	-
	Hexazinone	2.4	2.0	1.7	0.6	-
	Metribuzin	0.8	0.3	-	-	-
	Aldicarb	70.6	31.4	14.0	-	-
	Bentazone	140.0ppb	70.0ppb	34.9ppb	-	-

[1]Numbers refer to Figure 12.

TABLE 22. Continued

Site/County (Likely Depth to groundwater)	Pesticide	Computed Concentration/Health Standard or ppb at depths of 1.0m	1.5m	2.0m	3.0m	5.0m
15/Duchesne (D=3.0m)	Atrazine	6.9	4.9	2.8	0.1	-
	Diazinon	0.7	0.3	0.1	-	-
	Dicamba	7.1	3.2	3.2	1.6	-
	2,4-DB Amine	182.8ppb	69.2ppb	69.2ppb	8.1ppb	-
22/Emery (D=2.4m)						
30/Garfield (D=3.0m)	Carbofuran	13.9	10.1	5.7	-	-
	Dicamba	14.8	7.4	1.6	-	-
	2,4-DB Amine	56.9ppb	17.5ppb	6.6ppb	-	-
24/Grand (D=3.0)	Hexazinone	6.6	4.7	4.7	3.3	-
	Metribuzin	0.7	0.5	0.4	0.1	-
	Dicamba	3.4	0.8	0.8	-	-
	Atrazine	10.5	6.5	3.9	0.1	-
	Naptalam	19.5ppb	3.0ppb	0.3ppb	-	-
29/Iron (D=3.0m)	Metribuzin	0.5	0.3	0.2	-	-
	Hexazinone	3.1	2.2	1.9	0.9	-
	2,4-D Acid	0.1	-	-	-	-
	Aldicarb	100.8	0.1	-	-	-
	2,4-DB Amine	15.7ppb	2.0ppb	0.7ppb	-	-
18/Juab (D=2.0m)	Carbofuran	5.9	4.5	2.5	-	-
	Dicamba	1.9	0.4	-	-	-
	Diazinon	56.9	20.6	0.1	-	-
32/Kane (D=3.0m)	Simazine	6.6	0.5	0.4	0.2	-
	Metribuzin	1.4	1.0	0.5	0.2	-
	2,4-DB Amine	225.1ppb	85.3ppb	26.2ppb	1.2ppb	-

TABLE 22. Continued

Site/County (Likely Depth to groundwater)	Pesticide	Computed Concentration/Health Standard or ppb at depths of 1.0m	1.5m	2.0m	3.0m	5.0m
21/Millard (D=3.0m)	Carbofuran	14.3	8.2	5.9	-	-
	Hexazinone	3.1	2.6	2.2	1.3	-
	Metribuzin	2.6	2.1	1.3	0.5	-
	Trifluralin	0.2	-	-	-	-
	Dicamba	23.8	13.1	3.0	0.1	-
	2,4-DB Amine	522.6ppb	172.3ppb	20.2ppb	1.0ppb	-
	Oxydemeton-M.	140.0ppb	26.5ppb	-	-	-
	Chlorsulfuron	3.5ppb	9.5ppb	6.3ppb	-	-
9/Morgan (D=2.4m)	Hexazinone	4.7	3.3	3.3	1.9	0.2
	Dicamba	5.5	2.8	2.8	-	-
	Atrazine	0.5	-	-	-	-
26/Piute (D=3.0)	Carbofuran	7.9	6.1	-	-	-
3/Rich (D=3.0m)	Dicamba	1.9	0.4	0.4	-	-
	Diazinon	0.5	-	-	-	-
	Diuron	9.2	4.5	4.1	-	-
12/Salt Lake (D=4.2m)	Hexazinone	5.0	3.5	0.8	0.2	0.1
	Atrazine	3.2	0.2	0.2	-	-
	Carbofuran	15.9	9.0	2.8	-	-
28/San Juan (D=10.5m)						
19/SanPete (D=1.5m)	2,4-D Ester	3.5	1.7	0.4	-	-
	Carbofuran	9.9	7.4	5.7	2.3	-
	Metribuzin	0.9	0.6	0.4	0.2	-
	Atrazine	8.7	4.3	3.0	0.1	-
	2,4-D Acid	0.3	-	-	-	-
	Dicamba	7.8	1.7	0.8	-	-

TABLE 22. Continued

Site/County (Likely Depth to groundwater)	Pesticide	Computed Concentration/Health Standard or ppb at depths of 1.0m	1.5m	2.0m	3.0m	5.0m
23/Sevier (D=1.5m)	Hexazinone	1.9	1.6	1.4	0.8	-
	Metribuzin	0.5	0.3	0.2	0.1	-
	Carbofuran	37.5	21.4	12.0	5.2	-
	Atrazine	151.6	7.6	5.4	0.1	-
	Dicamba	20.9	10.5	4.7	0.2	-
	Barban	145.1	100.3ppb	72.5ppb	-	
10/Summit (3.0m)	Hexazinone	0.6	0.5	0.4	-	-
	2,4-D Acid	1.4	-	-	-	-
	Carbofuran	4.0	-	-	-	-
11/Tooele (D=3.0m)	Simazine	0.3	0.2	0.2	-	-
16/Uintah (D=1.8m)	Hexazinone	3.1	2.2	1.9	1.3	-
	Metribuzin	0.8	0.6	0.4	-	-
	Atrazine	6.9	4.2	2.5	0.1	-
	2,4-D Acid	1.7	0.6	-	-	-
17/Utah (D=2.4m)	Atrazine	5.4	4.2	2.5	0.1	-
	2,4-D Acid	0.9	0.3	-	-	-
	Diazinon	212.0	1.2	0.4	0.1	-
	Dicamba	9.5	3.4	1.5	0.8	-
14/Wasatch (1.5m)	Carbofuran	0.7	-	-	-	-
31/Washington (D=3.0m)	Hexazinone	2.25	1.84	1.84	1.3	
	Metribuzin	0.38	0.38	0.27	0.1	
27/Wayne (D=4.5m)	Carbofuran	13.1	10.1	7.4	-	-
	Dicamba	17.2	1.8	0.4	-	-

TABLE 22. Continued

Site/County (Likely Depth to groundwater)	Pesticide	Computed Concentration/Health Standard or ppb at depths of 1.0m	1.5m	2.0m	3.0m	5.0m
6/Weber (D=1.5m)	Carbofuran	5.4	4.4	-	-	-
	Metribuzin	0.8	0.5	0.1	-	-
	Hexazinone	1.9	1.9	1.4	0.8	0.8
	Metolachlor	204.5	77.8	53.5	15.62	-
	2-4,Acid	4.4	1.7	1.7	0.2	-
	Fonofos	0.1	-	-	-	-
	EPTC	0.1ppb	-	-	-	-
	Bentazone	159.2ppb	-	-	-	-

standard value. If health standards are not established, results are expressed as concentrations in parts per billion. Results reflect a single pesticide application and pesticide movement in the time period 1980 to 1985.

Groundwater tables are often subject to important temporal and spatial variation. Table 22 displays the most likely distance to the water table for the selected sites. Concentrations are predicted for five different depths aiding the reader to develop a feel for the likelihood of contaminant reaching the water table. As discussed in the previous section, any pesticide simulation deeper than a specified depth is valid only if the water table depth is below that depth.

Figure 13 aids interpretation of Table 22. The figure provides a listing of sites in decreasing order of concern. This order may change with changes in groundwater depth. Although, county names are used instead of site names, the listing applies to the sites in the counties (see Figure 8 for site identification).

Tables 23, 24, and 25 show a ranking of pesticide-location combinations and three different depths respectively: (a) at the most likely depth to groundwater; (b) at a depth of one meter; and (c) at a depth of three meters. The ratio of pesticide concentration over health standard is used as ranking criteria. If health standards are not established, ranking occurs according to concentrations in parts per billion. Table 26 shows the bounds that are used to establish Tables 23 through 25.

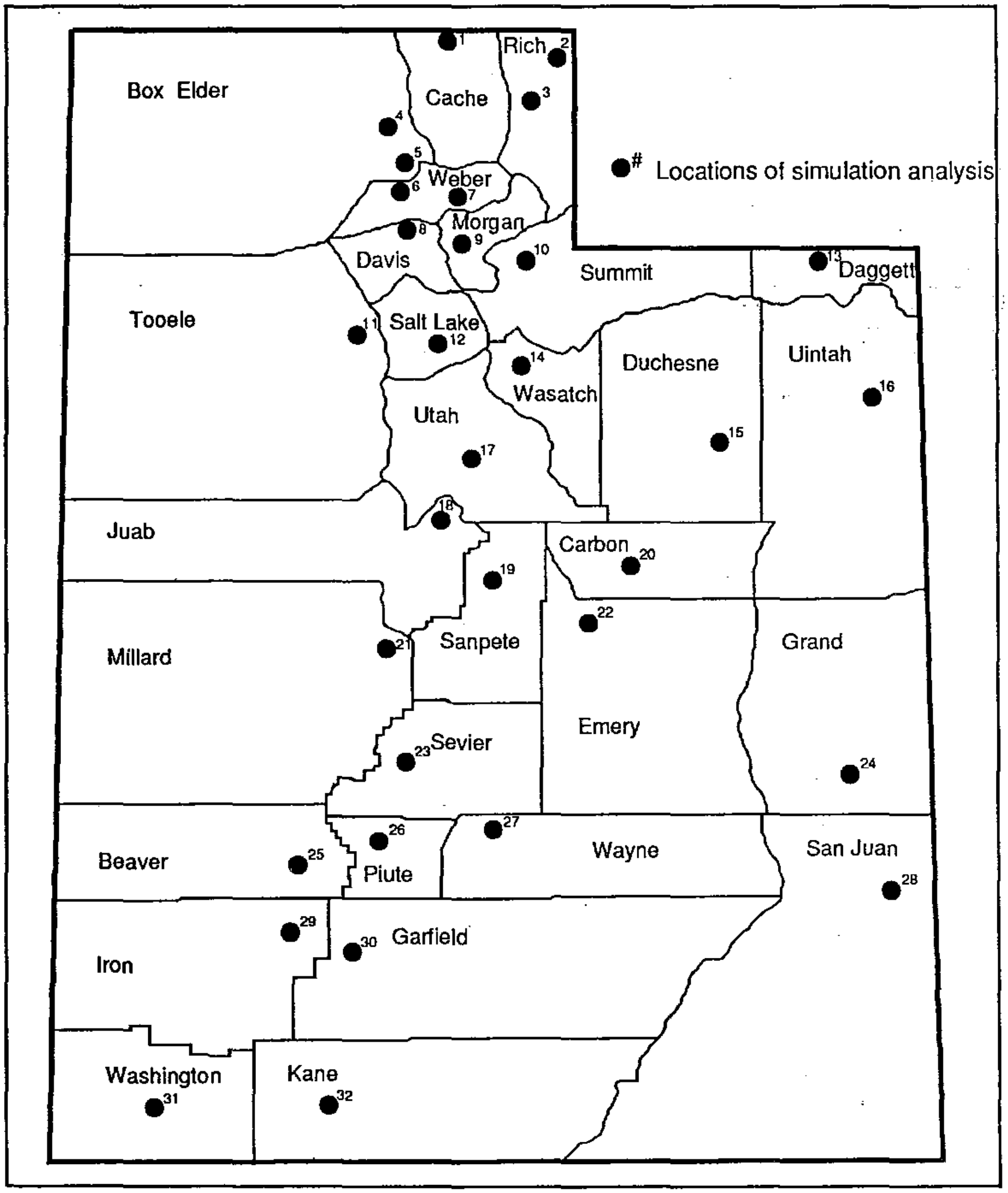


Figure 12. Numbering/Site Identification of Simulated Sites

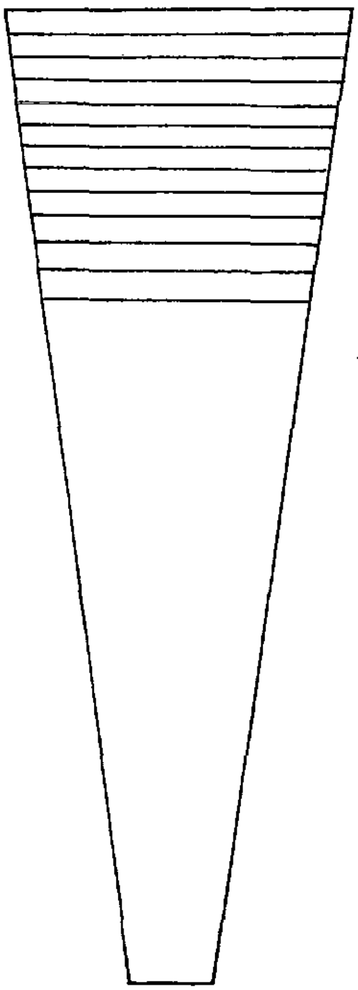
Measure of concern	Site/Counties
	6/Weber
	23/Sevier
	1/Cache
	19/SanPete
	25/Beaver
	13/Davis
	16/Uintah
	9/Morgan
	24/Grand
	17/Utah
	21/Millard
	18/Juab
	15/Duchesne
	29/Iron
	32/Kane
	12/Salt Lake

Figure 13. Ranking of Areas of Concern

TABLE 23. Ranking of Chemicals Most Likely Reaching Depth of Groundwater

Ratio or ppb	Pesticide	Site/County
77.8	Metolachlor	6/Weber
31.4	Aldicarb	8/Davis
21.4	Carbofuran	23/Sevier
10.5	Dicamba	23/Sevier
8.2	Atrazine	1/Cache
7.6	Atrazine	23/Sevier
7.4	Carbofuran	19/SanPete
4.4	Carbofuran	6/Weber
4.4	Carbofuran	25/Beaver
4.3	Dicamba	1/Cache
4.3	Atrazine	19/SanPete
4.2	Atrazine	16/Uintah
3.3	Hexazinone	9/Morgan
3.3	Hexazinone	24/Grand
2.8	Dicamba	9/Morgan
2.5	Carbofuran	18/Juab
2.2	Hexazinone	16/Uintah
2.1	Carbofuran	1/Cache
1.9	Hexazinone	6/Weber
1.7	2, 4-D Acid	6/Weber
1.7	Dicamba	19/SanPete
1.7	2, 4-D Ester	19/SanPete
1.6	Dicamba	15/Duchesne
1.6	Hexazinone	23/Sevier
1.4	2, 4-D	1/Cache
1.3	Hexazinone	21/Millard
1.0	Hexazinone	25/Beaver
100.3 ppb	Barban	23/Sevier
70.0 ppb	Bentazone	8/Davis
8.1 ppb	2, 4-DB Amine	15/Duchesne
7.4 ppb	Chlorsulfron	1/Cache

TABLE 24. Ranking of Chemicals at a Depth of 1.0 Meter

Ratio or ppb	Pesticide	Site/County
214.0	Atrazine	1/Cache
212.0	Diazinon	17/Utah
204.5	Metolachlor	6/Weber
151.6	Atrazine	23/Sevier
100.8	Aldicarb	29/Iron
70.6	Aldicarb	8/Davis
56.9	Diazinon	18/Juab
37.5	Carbofuran	23/Sevier
20.9	Dicamba	23/Sevier
17.2	Dicamba	27/Wayne
15.9	Carbofuran	12/Salt Lake
14.8	Dicamba	30/Garfield
14.3	Carbofuran	21/Millard
14.2	Carbofuran	25/Beaver
13.9	Carbofuran	30/Garfield
13.1	Carbofuran	27/Wayne
12.1	Dicamba	1/Cache
10.5	Atrazine	24/Grand
522.6 ppb	2, 4-DB Amine	21/Millard
225.1 ppb	2, 4-DB Amine	32/Kane
182.8 ppb	2, 4-DB Amine	15/Duchesne
159.2 ppb	Bentazone	6/Weber
145.0 ppb	Barban	23/Sevier
140.0 ppb	Oxydemeton-Methyl	21/Millard
56.9 ppb	2, 4-DB Amine	30/Garfield
46.2 ppb	Oxydemeton-Methyl	4/Box Elder
19.5 ppb	Naptalam	24/Grand
15.7 ppb	2, 4-DB Amine	29/Iron
12.0 ppb	Chlorsulfuron	1/Cache

TABLE 25. Ranking of Chemical at a Depth of 3.0 Meter

Ratio or ppb	Pesticide	Site/County
5.4	Atrazine	1/Cache
5.2	Carbofuran	23/Sevier
4.4	Carbofuran	25/Beaver
3.3	Hexazinone	24/Grand
2.3	Carbofuran	19/SanPete
1.9	Hexazinone	9/Morgan
1.9	Dicamba	1/Cache
1.6	Dicamba	15/Duchesne
1.3	Hexazinone	16/Uintah
1.3	Hexazinone	21/Millard
1.0	Hexazinone	25/Beaver
0.9	Hexazinone	29/Iron
0.8	Dicamba	17/Utah
0.8	Hexazinone	6/Weber
0.8	Hexazinone	23/Sevier
0.7	Hexazinone	1/Cache
0.6	Hexazinone	8/Davis
0.5	Metribuzin	21/Millard
8.1 ppb	2, 4-DB Amine	15/Duchesne
5.1 ppb	Chlorsulfron	1/Cache

TABLE 26. Bounds Used in Chemical Ranking

Table No.	Ratio	Concentration in ppb (if no health standards)
23	>1.0	>5.0
24	>10.0	>10.0
25	>0.5	>0.5

Interpretation of Results

Important contamination of extremely shallow aquifers can be expected. Interpretation of Appendix A and Tables 23 through 25 indicate that from the 64 chemicals applied in Utah (according to the survey):

a. 29 may reach, at certain locations, a depth of 1.0m;

b. 23 may reach this depth in important concentrations;

c. 22 may reach, at certain locations, a depth of 3.0m;

d. 18 may reach this depth in important concentrations;

e. 20 may reach, at certain locations, the most likely depth of groundwater; and

f. 13 may reach this depth in important concentrations.

In the simulations, only few chemicals reach a depth of 5.0 meters in significant concentrations. However trace concentrations of many chemicals may be subject to a deep leaching process.

Results shown in Table 23 through 25 are relative values. They allow one to compare the different sites and different pesticides. However, because of parameter uncertainty, it is very unlikely that field measurements will be in close agreement with the predicted values.

Results are computed for locations shown in Figure 8. These areas are identified by the DRASTIC procedure as potentially vulnerable areas. In comparison to other areas in a given county, these areas may often have a lighter textured soil and/or a higher than average groundwater table. However, soil is a highly variable media in space and characteristics of soil water and pesticide movement may change drastically within a short distance. Furthermore, macropores, which are not considered in this study, may cause unexpectedly rapid and deep movement of pesticide.

This study is based on information provided in the pesticide survey (Appendix B). It may well be that pesticide application practices are subject to change and that complementary analysis is required in case of such a change. Results do not reflect possible contamination as a consequence of accidental spills or application rates higher than those generally recommended.

The analysed sensitivity of pesticide movement due to changes in the organic carbon partition coefficient and half-life value has shown the important influence of these parameters. Change in assessment of the physical-chemical properties of a pesticide or in irrigation practices and efficiencies may lead to alternate pesticide movement patterns. An increase in the organic carbon partition coefficient, a decrease in half live time, and an increase in irrigation efficiency may all lead to a decrease in pesticide movement.

This study does not consider pesticide contamination of surface water and possible rapid infiltration of contaminated surface water. Such a process, when occurring in the recharge area, may lead to pesticide contamination of deep confined aquifers.

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

SUMMARY

Pesticide application patterns need to be known in order to assess the pesticide hazard to groundwater quality. A survey conducted within this study identifies the use of different pesticides in Utah. The resulting site specific information and pesticide library are given in the Appendices.

Sorption, dissipation, volatilization, application, water movement, water removal, and plant uptake are identified as processes affecting pesticide movement. Processes may be interdependent, and each one may depend on several factors. For the purpose of this study, factors are classified in categories. The main category includes pesticide properties, soil, agricultural practices, hydro-geology, climate, and topography.

Assessing potential groundwater contamination in a spatially extended system requires producing and evaluating an overwhelming amount of data. A screening procedure called agricultural DRASTIC was used to rapidly evaluate potential hazard to groundwater. The procedure is based on hydro-geological factors such as depth to groundwater, recharge rate, aquifer media, soil media, topography, vadose zone characteristics, and hydraulic conductivity of the aquifer. All influence factors are rated and combined into a weighted numerical value termed agricultural DRASTIC index. Plate 1 displays DRASTIC values for all agricultural areas in Utah. The highest index values for single points can be observed in locations in Wayne, Daggett, Duchesne, Weber, Cache, Kane, Summit, and Uintah Counties. Averages from several points are formulated to address the potential vulnerability of extended areas. The following hazard ranking can be established:

Highest 5 point averages: Wayne, Weber, Duchesne, Cache, Davis, Summit, Utah, Uintah.

Highest 10 point averages: Weber, Wayne, Cache, Davis, Utah, Wasatch, Duchesne, Summit, Juab.

Highest 15 point averages:

Highest 20 point averages: Weber, Wasatch, Cache, Utah.

The DRASTIC procedure, in its attempt to identify potentially hazardous zones, does not include pesticide related data such as rate, application date, incorporation, and physical-chemical properties of the pesticide itself. A simulation model known as CMLS-model (Chemical Movement in Layered Soil) is used to predict potential pesticide movement. CMLS is a one-dimensional management model that can be used to make decisions regarding the behavior of agrichemicals in soil. The model estimates the location of peak concentrations of pesticides in response to water movement.

CMLS is applied at the sites that are identified by DRASTIC as potentially hazardous. Based on an extensive series of computer simulations, it may be stated that from the pesticides applied in Utah:

a. 29 may reach, at certain locations, a depth of 1.0 meter;
b. 23 may reach this depth in important concentrations;
c. 22 may reach, at certain locations, a depth of 3.0 meters;
d. 18 may reach this depth in important concentrations;
e. 20 may reach, at certain locations, the most likely depth to groundwater; and
f. 13 may reach this depth in important concentrations.

Table 27 gives a ranking of the pesticide-site combinations that most likely might pose a threat to groundwater quality.

TABLE 27. Ranking of Pesticide-Site Combinations Posing a Threat to Groundwater Quality

Rank	Pesticide	Site/County	Rank	Pesticide	Site/County
1	Metolachlor	6/Weber	18	Carbofuran	18/Juab
2	Aldicarb	8/Davis	19	Hexazinone	16/Uintah
3	Carbofuran	23/Sevier	20	Carbofuran	1/Cache
4	Dicamba	23/Sevier	21	Hexazinone	6/Weber
5	Atrazine	1/Cache	22	2,4-D Acid	6/Weber
6	Atrazine	23/Sevier	23	Dicamba	19/Sanpte
7	Carbofuran	28/Sanpete	24	2,4-D Ester	19/Sanpete
8	Carbofuran	6/Weber	25	Dicamba	15/Duchesne
9	Carbofuran	25/Beaver	26	Hexazinone	23/Sevier
10	Dicamba	1/Cache	27	2,4-D Acid	1/Cache
11	Atrazine	28/Sanpete	28	Hexazinone	21/Millard
12	Barban	23/Sevier	29	Hexazinone	25/Beaver
13	Bentazone	8/Davis	30	Chlorsulfuron	1/Cache
14	Atrazine	16/Uintah	31	Aldicarb	29/Iron
15	Hexazinone	9/Morgan	32	2,4-DB Amine	21/Millard
16	Hexazinone	24/Grand	33	Oxydemeton-Methyl	21/Millard
17	Dicamba	9/Morgan			

However, soil is a highly variable media, depth to groundwater varies in time and space, irrigation efficiencies depend on farmers, and the chemical-physical properties of many pesticides are not very clearly known. Furthermore, macropores, which are not considered in this study, might lead to unexpectedly rapid and deep movement of pesticides. Therefore, pesticides not included in Table 27 may be found at sites other than those listed.

CONCLUSIONS

Pesticide Contamination of Groundwater

In Utah, contamination of shallow groundwater can be expected. Based on a screening procedure using hydro-geological factors, agricultural areas in Weber, Wayne, Cache, Davis, Utah, Wasatch, Duchesne, Summit, and Juab Counties should be considered as most vulnerable to groundwater contamination.

Extensive computer simulation of pesticide movement, at locations identified by the screening procedure, allows ranking of areas according to their combined pesticide-site contamination potential. Sixteen sites are identified and ranked in Figure 14.

The site ranking is highly dependent on the distance to the groundwater. However, this distance is not always well known, and rankings may be changed with changing depth to groundwater.

Procedure Applied in this Study

The two step procedure applied in this study represents a valid approach for assessing potential groundwater contamination in a spatially extended system. The first step, screening a large number of sites, allows reduction of the

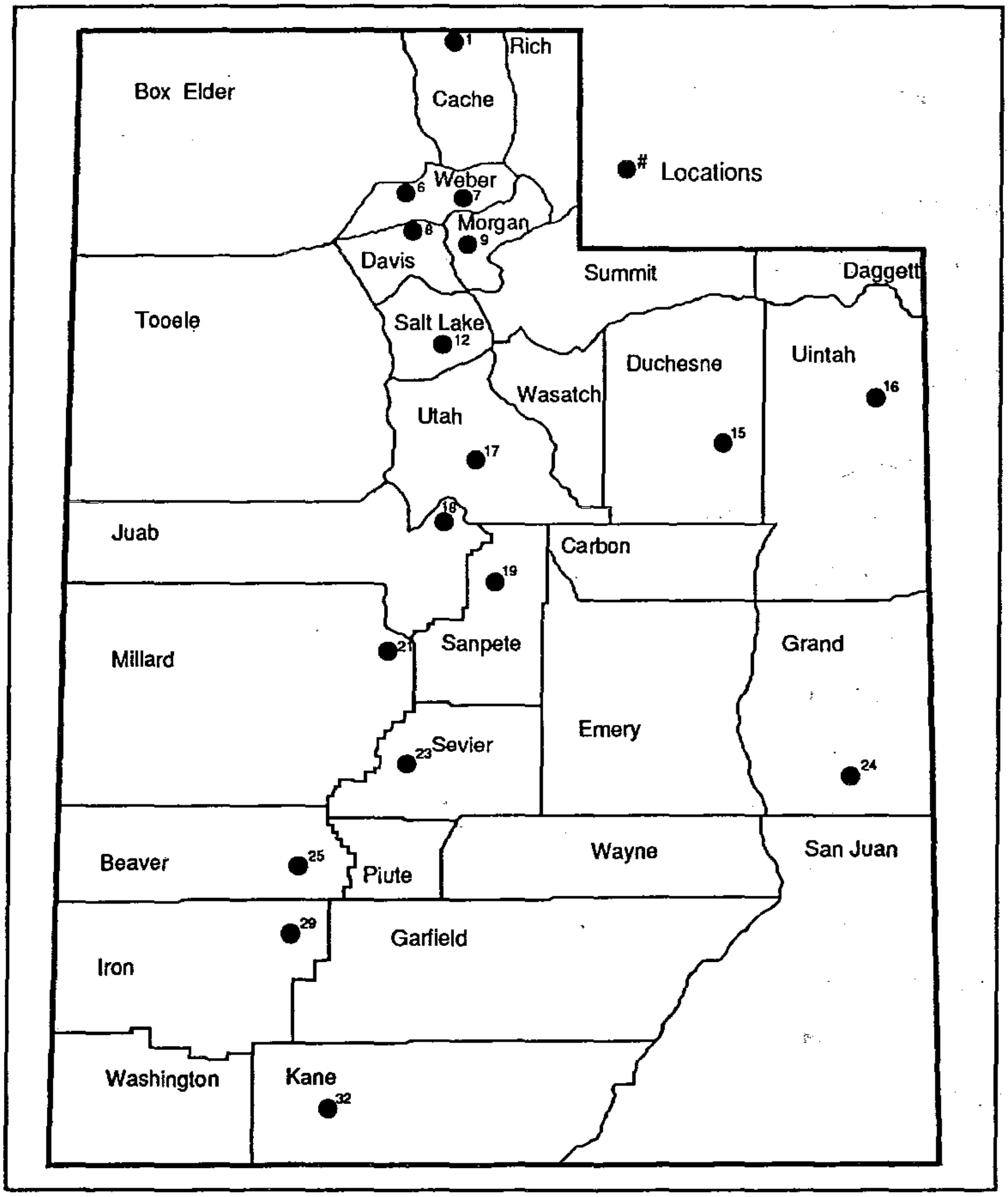


Figure 14. Location of Potentially Hazardous Pesticide-Site Combinations.

number of sites to investigate, thereby focusing attention on the potentially hazardous sites. The second step, simulating pesticide movement, allows ranking of the potentially hazardous pesticide-site combinations.

RECOMMENDATIONS

Sampling to Assess the Present Situation

Sampling of groundwater for pesticide contamination is imperative, however, objectives of a sampling program need to be established with care. One may look for:

a. A particular pesticide such as aldicarb or diazinon, or for a broad range of different pesticides;

b. Pesticides in deep or shallow aquifers; and

c. pesticides in groundwater supplying public water supplies or providing drinking water to individual farms.

Once the objectives are clearly identified, sampling priorities can be established. Sampling for a variety of pesticides may utilize the information given in Figure 14.

Sampling for particular pesticide might be oriented according to the listing in Table 27. In that case one would search for aldicarb contamination in Davis and Iron Counties. One would seek atrazine contamination in Cache, Sevier, Sanpete, and Uintah Counties.

Once sampling areas are identified, the selection of sampling wells and sampling times require special attention. The results of a sampling program depends on the "careful selection" of sampling sites and sampling times. Remember that the likelihood of finding pesticides in water samples from shallow

Remember that the likelihood of finding pesticides in water samples from shallow aquifers:

1. Decreases with increasing depth to the groundwater;
2. Decreases with increasing distance between the pesticide application site and the sampling site;
3. Increases with decreasing irrigation efficiency;
4. Depends on pesticide application and irrigation timing; and
5. Is virtually nil if the pesticide is applied downstream (in terms of groundwater flow) from the sampling site.

Prevent Contamination

Results of this study indicate that pesticide selection and agricultural practices such as pesticide incorporation, irrigation, and the time of pesticide application can significantly influence pesticide movement. These influences should be investigated further and quantified. In addition, site-specific strategies should be developed in order to prevent pesticide movement to groundwater.

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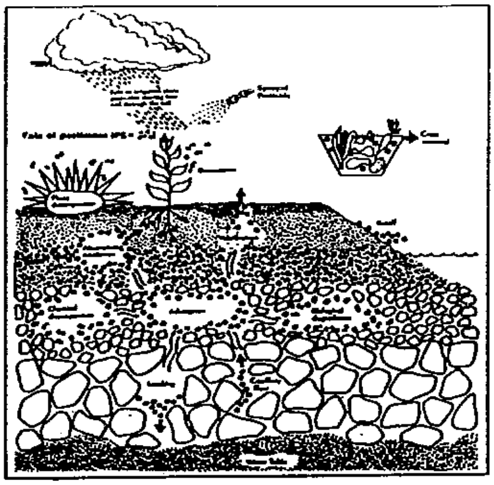
AGRICULTURAL PESTICIDE HAZARD TO GROUNDWATER IN UTAH

PART II: APPENDICES



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APPENDIX A

CMLS Analysis

CMLS-Analysis: Beaver County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	1.12	1.0	42	0.4553	509.9	36	14.2
			1.5	56	0.3503	392.3		10.9
			2.0	73	0.2547	285.3		7.9
			3.0	64	0.1425	159.6		4.4
	Parathion/ Thiophos	0.56	1.0	1676	-			
			1.5	1676	-			
			2.0	1676	-			
			3.0	1676	-			
	Hexazinone/ Velpar	1.12	1.0	88	0.3618	405.2	210	1.9
			1.5	102	0.3078	344.7		1.6
			2.0	118	0.2558	286.5		1.4
			3.0	149	0.1788	200.3		1.0
Corn	Atrazine/ Aatrex	2.24	1.0	384	0.0118	26.4	3	8.8
			1.5	426	0.0073	16.4		5.5
			2.0	488	0.0036	8.1		2.7
			3.0	775	0.0001	0.2		0.1
	2,4-D Amine	0.84	1.0	360	1.5E-11		70	
			1.2	421	2.1E-13			
			2.0	452	2.5E-14			
			3.0	725	1.5E-22			
	Carbofuran/ Furadan	1.12	1.0	45	0.4304	482.0	36	13.4
			1.5	75	0.2454	274.8		7.6
			2.0	106	0.1373	153.8		4.3
			3.0	684	0.0008	0.9		2.5E-2

'LS-Analysis: Box Elder County (1/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Pronamide/ Kerb	1.12	1.0	2035	-		52	
			1.5	2035	-			
			2.0	2035	-			
			3.0	2035	-			
	2,4-DB Amine	1.68	1.0	301	87E-10			
			1.5	381	3.4E-12			
			2.0	442	4.9E-14			
			3.0	746	3.5E-23			
	EPTC/Eptam	4.48	1.0	842	3.6E-9			
			1.5	1117	1.5E-12			
			2.0	1559	2.3E-16			
			3.0	2107	-			
	Parathion/ Thiophos	0.56	1.0	1681	-			
			1.5	1681	-			
			2.0	1681	-			
			3.0	1681	-			
	Carbofuran/ Furadan	1.12	1.0	83	0.2112	236.54	36	6.57
			1.5	159	0.0509	57.0	1.58	
			2.0	401	0.0005	0.56		0.02
			3.0	569	2.3E-5			
	Metribuzin/ Sencor,Lexone	1.12	1.0	278	0.0016	1.79	175	0.01
			1.5	326	0.0005			
			2.0	529	4.9E-6			
			3.0	674	1.7E-7			
Corn	Alachlor/ Lasso	3.36	1.0	539	2.6E-12		1.5	
			1.5	842	7.9E-19			
			2.0	1151	1.8E-25			
			3.0	1559	3.0E-34			
	Cyanazine/ Bladex	2.24	1.0	463	1.1E-7		9	
			1.5	812	6.0E-13			
			2.0	1098	3.0E-17			
			3.0	1517	1.5E-23			
	Atrazine/ Aatrex	2.24	1.0	463	0.0048	10.75	3	3.58
			1.5	798	9.9E-5	0.22		0.07
			2.0	1087	3.5E-6			
			3.0	1507	2.7E-8			

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	2,4-D Acid	0.84	1.0	97	0.0012		70	
			1.5	356	1.9E-11			
			2.0	370	7.3E-12			
			3.0	646	3.6E-20			
	Oxydemeton-Methyl/Metasystox-R	0.56	1.0	72	0.0825	46.2		
			1.5	319	1.6E-5	0.01		
			2.0	345	6.4E-6			
			3.0	543	6.7E-9			
	Propargite/ Omite	1.90	1.0	2005	-			
			1.5	2005	-			
			2.0	2005	-			
			3.0	2005	-			
	Disulfoton/ Disyston	0.56	1.0	2005	-		0.3	
			1.5	2005	-			
			2.0	2005	-			
			3.0	2005	-			
Winter Small Grains								
	Disulfoton/ Disyston	1.12	1.0	1893	-		0.3	
			1.5	1893	-			
			2.0	1893	-			
			3.0	1893	-			
	Dimethoate/ Cygon	0.42	1.0	145	4.3E-5			
			1.5	453	3.3E-20			
			2.0	614	3.9E-27			
			3.0	887	7.2E-39			
	2,4-D Acid	1.12	1.0	145	4.3E-5		70	
			1.5	391	1.7E-12			
			2.0	494	1.3E-15			
			3.0	735	7.5E-23			
	Bromoxynil/ Brominal	0.56	1.0	1686	-			
			1.5	1686	-			
			2.0	1686	-			
			3.0	1686	-			

'LS-Analysis: Box Elder County (3/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Onions								
	DCPA/	1.12	1.0	2051	-		3500	
	Dacthal		1.5	2051	-			
			2.0	2051	-			
			3.0	2051	-			
	Oxyfluorfen/	0.28	1.0	2051	-			
	Goal		1.5	2051	-			
			2.0	2051	-			
			3.0	2051	-			
	Bromoxynil/	0.42	1.0	2051	-			
	Brominal		1.5	2051	-			
			2.0	2051	-			
			3.0	2051	-			
	Parathion/	0.84	1.0	2009	-			
	Thiophos		1.5	2009	-			
			2.0	2009	-			
			3.0	2009	-			
	Azinphos-	0.84	1.0	2009	-			
	Methyl/Guthion		1.5	2009	-			
			2.0	2009	-			
			3.0	2009	-			
	Methyl-	0.56	1.0	2009	-		2	
	Parathion/		1.5	2009	-			
	Penncap-M		2.0	2009	-			
	Metafos		3.0	2009	-			
Apples/	Dormant Oil	0.84	1.0					
Cherries/			1.5					
Peaches			2.0					
			3.0					
	Azinphos-	2.80	1.0	2041	-			
	Methyl/Guthion		1.5	2041	-			
			2.0	2041	-			
			3.0	2041	-			
	Benomyl/		1.0	2041	-			
	Benlate		1.5	2041	-			
			2.0	2041	-			
			3.0	2041	-			

CMLS-Analysis: Box Elder County (4/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Phosmet/ Imidan	4.48	1.0	1934	1.5E-6			
			1.5	2025	-			
			2.0	2025	-			
			3.0	2025	-			

MLS-Analysis: Cache County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Parathion/	0.84	1.0	1363	4.9E-30	4.1E-27		
	Thiophos		1.5	1560	2.0E-34			
			2.0	1943	1.7E-42			
			3.0	2046	-			
	Carbofuran/	1.12	1.0	123	0.0998	112	36	3.1
	Furadan		1.5	133	0.0828	93		2.6
			2.0	144	0.0674	75		2.1
			3.0	387	0.0007	0.8		0.02
	Malathion/	1.68	1.0	<2020	-			
	Calmathion		1.5	<2020	-			
			2.0	<2020	-			
			3.0	<2020	-			
	Hexazinone/	1.12	1.0	144	0.1895	212	210	1.0
	Velpar		1.5	153	0.1708	191		0.9
			2.0	153	0.1708	191		0.9
			3.0	174	0.1340	150		0.7
	Metribuzin/	0.56	1.0	153	0.0292	16	175	0.09
	Sencor, Lexone		1.5	163	0.0231	13		0.07
			2.0	174	0.0179	10		0.06
			3.0	417	6.5E-5			
Dry Land	2,4-D	1.12	1.0	529	1.2E-16		70	
Winter	Acid		1.5	626	1.4E-19			
Wheat			2.0	682	2.9E-21			
			3.0	939	5.4E-29			
	Metsulfuron/	0.0043	1.0	659	0.0222	0.10		
	Ally		1.5	894	0.0057	0.02		
			2.0	929	0.0047	0.02		
			3.0	1112	0.0016			
	Chlorsulfuron/	0.027	1.0	341	0.0004	0.01		
	Glean		1.5	619	6.1E-7			
			2.0	691	1.2E-7			
			3.0	892	1.1E-9			
Irrigated	2,4-D Acid	1.12	1.0	41	0.1693	190	70	2.7
Small			1.5	41	0.1693	190		2.7
Grains			2.0	57	0.0846	95		1.4
			3.0	326	7.4E-7			

CMLS-Analysis: Cache County (2/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Metsulfuron/	0.0043	1.0	62	0.6970	3.0		
	Ally		1.5	78	0.6373	2.7		
			2.0	92	0.5898	2.5		
			3.0	427	0.0849	0.4		
	Chlorsulfuron/	0.027	1.0	35	0.4454	12.0		
	Glean		1.5	35	0.0454	12.0		
			2.0	56	0.2742	7.4		
			3.0	72	0.1895	5.1		
	Dicamba/	0.14	1.0	5	0.7807	109	9	12.1
	Banvel		1.5	26	0.2760	39		4.3
			2.0	26	0.2760	39		4.3
			3.0	42	0.1250	18		1.9
Corn	Phorate/	1.73	1.0	1122	0.0002	0.4	2	
	Thimet		1.5	1245	6.9E-5	0.1		
			2.0	1502	9.5E-6			
			3.0	1959	2.8E-7			
	Fonofos/	1.12	1.0	787	0.0001	0.11	14	0.01
	Dyfonate		1.5	874	4.1E-5			
			2.0	1110	2.7E-6			
			3.0	1359	1.5E-7			
	Fensulfothion/		1.0					
	Dasanit		1.5					
			2.0					
			3.0					
	Alachlor/	3.36	1.0	139	0.0010	3.4	1.5	2.2
	Lasso		1.5	349	3.1E-8			$6.9 \cdot 10^{-5}$
			2.0	406	1.9E-9			
			3.0	456	1.6E-10			
	Atrazine/	2.24	1.0	108	0.2872	643	3.0	214
	Aatrex		1.5	153	0.1708	383		128
			2.0	390	0.0110	25		8.2
			3.0	426	0.0073	16		5.4
	Metolachlor/	2.24	1.0	119	0.0162	36	10	3.6
Dual			1.5	377	2.1E-6	4.7-3		
			2.0	392	1.3E-6			
			3.0	467	9.4E-8			

MLS-Analysis: Cache County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Cyanazine/	2.24	1.0	122	0.0146	33	9	3.6
	Bladex		1.5	153	0.0050	11		1.2
			2.0	400	9.5E-7	0.002		
			3.0	442	2.2E-7			
	EPTC/	4.48	1.0	386	0.0001	0.5		
	Eptam		1.5	411	7.5E-5			
			2.0	472	1.8E-5			
			3.0	750	3.0E-8			
	Atrazine and		1.0					
	Metolachlor/Bicep		1.5					
			2.0					
			3.0					
Vege-	Trifluralin/	1.12	1.0	1836	1.2E-8		2.0	
table	Treflan		1.5	>2066				
			2.0	>2066				
			3.0	>2066				
Apples	Propargite/		1.0	>2066				
	Omite		1.5	>2066				
			2.0	2066				
			3.0	2066				
	Phosalone/		1.0	>2066				
	Zolone		1.5	>2066				
			2.0	>2066				
			3.0	>2066				

CMLS-Analysis: Carbon County (1/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	1.12	1.0	66	0.2904	325.25	36	9.03
			1.5	97	0.1625	182		5.06
			2.0	114	0.1182	132.38		3.68
			3.0	431	0.0003	0.34		0.01
	Methidathion/ Supracide	1.12	1.0	1878	1.2E-27			
			1.5	>2061	-			
			2.0	>2061	-			
			3.0	>2061	-			
	2,4 - D Ester	0.84	1.0	>2035	-		70	
			1.5	>2035	-			
			2.0	>2035	-			
			3.0	>2035	-			
	Parathion/ Thiophos	0.56	1.0	>2039	-			
			1.5	>2039	-			
			2.0	>2039	-			
			3.0	>2039	-			
	Chlorpyrifos/ Lorsban	1.12	1.0	2071	-			
			1.5	2071	-			
			2.0	2071	-			
			3.0	2071	-			
Corn	2,4-D Acid	0.84	1.0	87	0.0024		70	
			1.5	360	1.5E-11			
			2.0	390	1.8E-12			
			3.0	435	8E-14			
Corn	2,4-D Ester	0.84	1.0	>2034	-		70	
			1.5	>2034	-			
			2.0	>2034	-			
			3.0	>2034				
	Glyphosate/ Roundup	2.24	1.0	>2081	-		700	
			1.5	>2081	-			
			2.0	>2081	-			
			3.0	>2081	-			
Small Grains	2,4-D - Acid	1.12	1.0	44	0.0474		70	
			1.5	395	1.3E-12			
			2.0	409	4.9E-13			
			3.0	499	9.5E-16			

MLS-Analysis: Carbon County (2/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
	Dicamba/	0.14	1.0	30	0.2264	31.7	9	3.52
	Banvel		1.5	44	0.1132	15.85		1.76
			2.0	379	7.1E-9			
			3.0	409	1.6E-9			

CMLS-Analysis: Davis County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan (I)	1.12	1.0	103	0.1452	162.62	36	4.52
			1.5	346	0.0015	1.68		0.05
			2.0	360	0.0012	1.34		0.04
			3.0	421	0.004	0.45		0.01
	Sethoxydim/ Poast	0.42	1.0	93	2.5E-6			
			1.5	107	3.6E-7			
			2.0	169	6.7E-11			
			3.0	411	1.8E-25			
	Hexazinone/ Velpar	1.12	1.0	71	0.4403	493.14	210	2.35
			1.5	87	0.366	409.92		1.95
			2.0	101	0.3114	348.77		1.66
			3.0	190	0.114	124.77		0.59
Corn	Metolachlor/ Dual	2.24	1.0	422	4.4E-7		10	
			1.5	626	3.8E-1			
			2.0	745	6.1E-12			
			3.0	863	1E-13			
	Alachlor/ Alanex, Lasso	3.36	1.0	406	1.9E-9		1.5	
			1.5	529	4.2E-12			
			2.0	735	1.6E-16			
			3.0	801	6E-18			
	Cyanazine/ Bladex	0.67	1.0	392	1.3E-6		9	
			1.5	467	9.4E-8			
			2.0	626	3.8E-10			
			3.0	771	2.5E-12			
Potatoes	Metolachlor/ Dual	2.24	1.0	487	4.7E-8		10	
			1.5	740	7.3E-12			
			2.0	775	2.2E-12			
			3.0	909	2.1E-14			
	Metribuzin/ Sencor, Lexone	0.56	1.0	59	0.2558	143.25	175	0.82
			1.5	108	0.0825	46.2		0.26
			2.0	326	0.005	0.28		1.6E-3
			3.0	389	0.001			
	Azinphoz-Methyl/ Guthion	0.42	1.0	2030	-			
			1.5	2030	-			
			2.0	2030	-			
			3.0	2030	-			

CMLS-Analysis: Davis County (2/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Aldicarb/ Temik	2.24	1.0	50	0.3150	705.6	10	70.56
			1.5	85	0.1403	314.27		31.43
			2.0	120	0.0625	140		14.0
			3.0	387	0.0001	0.22		0.02
Onions	DCPA/ Dacthal	11.2	1.0	2096	-		3500	
			1.5	2096	-			
			2.0	2096	-			
			3.0	2096	-			
	Oxyfluorfen/ Goal	0.28	1.0	2066	-			
			1.5	2066	-			
			2.0	2066	-			
			3.0	2066	-			
	Methyl Parathion/ Penncap-M	0.56	1.0	2035	-		2	
			1.5	2035	-			
			2.0	2035	-			
			3.0	2035	-			
	Fluazifop-Butyl/ Fusilade	0.28	1.0	2066	-			
			1.5	2066	-			
			2.0	2066	-			
			3.0	2066	-			
Winter Wheat	2,4-D Ester	0.56	1.0	1527	9.8E-45		70	
			1.5	1696	-			
			2.0	1696	-			
			3.0	1696	-			
	Triallate/ Fargo	1.12	1.0	1918	-			
			1.5	1918	-			
			2.0	1918	-			
			3.0	1918	-			
	Difenzoquat Avenge	1.12	1.0	1726	-			
			1.5	1726	-			
			2.0	1726	-			
			3.0	1726	-			

CMLS-Analysis: Davis County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Carbaryl/ Sevin	1.68	1.0	770	7.7E-34		700	
			1.5	934	6.8E-41			
			2.0	1122	7E-45			
			3.0	1633	7E-45			
Snap Beans								
	Bentazone / Basagran							
		1.12	1.0	30	0.1250	140		
			1.5	40	0.0625	70		
			2.0	50	0.0315	34.94		
	Trifluralin/ Treflan	0.84	1.0	2091	-		2	
			1.5	2091	-			
			2.0	2091	-			
			3.0	2091	-			
	Malathion/ Carbofos	1.12	1.0	2009	-			
			1.5	2009	-			
			2.0	2009	-			
			3.0	2009	-			

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	2,4-DB Amine	1.68	1.0	32	0.1088	182.78		
			1.5	46	0.0412	69.22		
			2.0	46	0.0412	69.22		
			3.0	77	0.0048	8.06		
	Methyl-Parathion/ Metafos, Penncap-M	0.56	1.0	2020			2	
			1.5	2020				
			2.0	2020				
			3.0	2020				
	Malathion/ Carbofos	1.4	1.0	2020				
			1.5	2020				
			2.0	2020				
			3.0	2020				
Corn	Atrazine/ Aatrex	2.69	1.0	421	0.0077	20.71	3	6.9
			1.5	451	0.0055	14.8		4.93
			2.0	499	0.0031	8.34		2.78
			3.0	786	0.0001	0.27		0.09
	EPTC/ Eptam	4.48	1.0	772	1.8E-8	8.06E-5		
			1.5	816	6.5E-9			
			2.0	878	1.5E-9			
			3.0	1181	1.4E-12			
	2,4-DB Amine	1.68	1.0	41	0.0583	97.94		
			1.5	57	0.0192	32.26		
			2.0	88	0.0022	3.7		
			3.0	133	9.9E-5	0.17		
	Diazinon/ Dianon	2.24	1.0	370	0.0002	0.45	0.63	0.71
			1.5	400	9.7E-5	0.22		0.34
			2.0	448	3.2E-5	0.07		0.11
			3.0	721	5.8E-8	1.3E-4		2.06E-4
Small Grains	Dicamba/ Banvel	0.14	1.0	16	0.4529	63.4	9.0	7.1
			1.5	32	0.2051	28.7		3.2
			2.0	32	0.2051	28.7		3.2
			3.0	46	0.1025	14.4		1.6
	2,4-DB Amine	2.24	1.0	32	0.1088	243.71		
			1.5	46	0.0412	92.29		
			2.0	46	0.0412	92.29		
			3.0	381	3.4E-12	7.62E-9		

CMLS-Analysis: Emery County (1/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Methidathion/ Supracide	0.84	1.0	1518	1.7E-22			
			1.5	1836	4.8E-27			
			2.0	1914	3.7E-28			
			3.0	>2035	-			
	Glyphosate/ Roundup	1.68	1.0	>2070	-		700	
			1.5	2070	-			
			2.0	2070	-			
			3.0	2070	-			
Corn	EPTC/ Eptam	3.36	1.0	771	1.8E-8			
			1.5	849	3E-8			
			2.0	863	2.2E-9			
			3.0	1152	2.8E-12			
	2,4-D Amine	0.56	1.0	370	7.3E-12		70	
			1.5	418	2.6E-13			
			2.0	452	2.5E-24			
			3.0	721	2E-22			
Melons	Bensulide/ Prefar	0.56	1.0	>2066	-			
			1.5	2066	-			
			2.0	2066	-			
			3.0	2066	-			
	Naptalam/ Alanap	3.36	1.0	57	0.0035	11.76		
			1.5	76	0.0005	1.68		
			2.0	97	6.7E-5			
			3.0	392	1.4E-17			
	Trifluralin/ Treflan	0.84	1.0	>2038	-		2	
			1.5	2038	-			
			2.0	2038	-			
			3.0	2038	-			
	Chlorothalonil/ Bravo		1.0	>2028	-		1.5	
			1.5	2028	-			
			2.0	2028	-			
			3.0	2028	-			
Apples/ Peaches	Azinphos-Methyl/ Guthion	2.24	1.0	1913	4E-15			
			1.5	>2020	-			
			2.0	2020	-			
			3.0	2020	-			

'LS-Analysis: Emery County (2/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Glyphosate/ Roundup	1.68	1.0	>2061	-		700	
			1.5	>2062	-			
			2.0	>2061	-			
			3.0	>2061	-			

CMLS-Analysis: Garfield County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	1.12	1.0	43	0.4468	500.4	36	13.9
			1.5	60	0.3250	364		10.1
			2.0	91	0.1818	203		5.7
			3.0	394	0.0006	0.7		1.9E-2
	2,4-DB Amine	1.12	1.0	43	0.0508	56.9		
			1.5	60	0.0156	17.5		
			2.0	74	0.0059	6.6		
			3.0	394	1.4E-12	-		
	Dicamba/ Banvel	0.56	1.0	29	0.2379	133.2	9	14.8
			1.5	43	0.1190	66.6		7.4
			2.0	74	0.0256	14.3		1.6
			3.0	378	7.5E-9	4.2E-6		4.7E-7
	Gylyphosate/ Roundup	3.36	1.0	1673	-		700	
			1.5	1673	-			
			2.0	1673	-			
			3.0	1673	-			

'.S-Analysis: Grand County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Malathion/ Carbofos	1.40	1.0	>2041	-			
			1.5	>2041	-			
			2.0	>2041	-			
			3.0	>2041	-			
	Hexazinone/ Velpar	1.68	1.0	16	0.8312	1396	210	6.6
			1.5	46	0.5878	988		4.7
			2.0	46	0.5878	988		4.7
			3.0	77	0.4108	690		3.3
	Metribuzin/ Sencor, Lexone	0.84	1.0	82	0.1504	126	175	0.7
			1.5	96	0.1088	91		0.5
			2.0	113	0.0735	62		0.4
			3.0	158	0.0260	22		0.1
	Pronamide/ Kerb	2.24	1.0	1705	7.8E-18	-	52	-
			1.5	>1888	-	-		-
			2.0	>1888	-	-		-
			3.0	>1888	-	-		-
	Sethoxydim/ Poast	0.53	1.0	66	0.0001	0.1		
			1.5	83	1.0E-5	-		
			2.0	114	1.4E-7	-		
			3.0	431	1.1E-26	-		
Small Grains	2,4-D Ester	1.06	1.0	>2056	-	-	70	
			1.5	>2056	-			
			2.0	>2056	-			
			3.0	>2056	-			
	2,4-D Amine	1.06	1.0	396	1.2E-12	-	70	
			1.5	426	1.5E-13	-		
			2.0	506	5.9E-16	-		
			3.0	791	1.5E-24	-		
	Dicamba/ Banvel	0.14	1.0	31	0.2155	30.2	9.0	3.4
			1.5	61	0.0488	6.8		0.8
			2.0	61	0.0488	6.8		0.8
			3.0	426	6.9E-10	-		-
Corn	2,4-D Amine	0.84	1.0	365	1.0E-11	-	70	
			1.5	395	1.3E-12	-		
			2.0	440	5.7E-14	-		
			3.0	730	1.1E-22	-		

CMLS-Analysis: Grand County (2/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Cyanazine/ Bladex	3.36	1.0	406	7.7E-7	-	9.0	
			1.5	453	1.5E-7	-		
			2.0	517	1.7E-8	-		
			3.0	832	3.0E-13	-		
	Atrazine/ Aatrex	2.69	1.0	385	0.0117	31.5	3.0	10.5
			1.5	427	0.0072	19.4		6.5
			2.0	472	0.0043	11.6		3.9
			3.0	776	0.0001	0.3		0.1
Melons	Bensulide/ Prefar	6.72	1.0	>2096	-	-	-	
			1.5	>2096	-	-		
			2.0	>2096	-	-		
			3.0	>2096	-	-		
	Naptalam/ Alanap	3.36	1.0	52	0.0058	19.5	-	
			1.5	71	0.0009	3.0		
			2.0	92	0.0001	0.3		
			3.0	387	2.3E-17	-		
	Trifluralin/ Treflan	0.84	1.0	>2056		-	2.0	
			1.5	>2056		-		
			2.0	>2056		-		
			3.0	>2056		-		
	Glyphosate/ Roundup	3.36	1.0	>2056		-	700	
			1.5	>2056		-		
			2.0	>2056		-		
			3.0	>2056		-		
Orchards	Dormant Oil		1.0	1536	9.8E-45	-	-	
			1.5	1901	-	-		
			2.0	>2100		-		
			3.0	>2100		-		
	Diazinon/ Dianon	5.0	1.0	136	0.0432	216	0.63	343
			1.5	167	0.0211	106		168
			2.0	197	0.0105	53		83
			3.0	487	1.3E-5	0.1		0.1
	Endosulfan/ Thiodan		1.0	>2100	-	-	-	
			1.5	>2100	-	-		
			2.0	>2100	-	-		
			3.0	>2100	-	-		

LS-Analysis: Grand County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Fenvalerate/ Pydrin		1.0	>2100	-	-	-	
			1.5	>2100	-	-		
			2.0	>2100	-	-		
			3.0	>2100	-	-		
	Azinphos-Methyl/ Guthion		1.0	1536	2.8E-12	-	-	
			1.5	1901	4.9E-15	-		
			2.0	>2100	-	-		
			3.0	>2100	-	-		
	Propargite/ Omite		1.0	>2100	-	-	-	
			1.5	>2100	-	-		
			2.0	>2100	-	-		
			3.0	>2100	-	-		
	Chlorpyrifos/ Lorsban		1.0	>2100	-	-	-	
			1.5	>2100	-	-		
			2.0	>2100	-	-		
			3.0	>2100	-	-		
	Daminozide/ Alar		1.0	61	0.0024	-	-	
			1.5	105	3.1E-5	-		
			2.0	153	2.6E-7	-		
			3.0	197	3.4E-9	-		

CMLS-Analysis: Iron County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Parathion/ Thiophos	1.12	1.0	>2034	-	-	-	
			1.5	>2034	-	-		
			2.0	>2034	-	-		
			3.0	>2034	-	-		
	Permethin/ Pounce, Ambush	1.12	1.0	>2034	-	-	-	
			1.5	>2034	-	-		
			2.0	>2034	-	-		
			3.0	>2034	-	-		
	Metribuzin/ Sencor	0.56	1.0	77	.168	94.1	175	0.5
			1.5	108	.082	45.9		0.3
			2.0	122	.059	28.6		0.2
			3.0	456	2.7E-5	-		-
	Hexazinone/ Velpar	1.12	1.0	47	.581	651	210	3.1
			1.5	77	.41	459		2.2
			2.0	91	.35	392		1.9
			3.0	153	.17	190		0.9
	2, 4-DB Amine Salt	1.12	1.0	61	.014	15.7	-	
			1.5	91	.0018	2.0		
			2.0	108	.0006	0.7		
			3.0	426	1.5E-19	-		
Small Grains	2, 4-D Acid	.56	1.0	61	.014	7.8	70	0.1
			1.5	91	.0018	1.0		
			2.0	91	.0018	1.0		
			3.0	442	9.4E-14	-		
Potatoes	Aldicarb/ Temik	3.36	1.0	52	.3008	1008	10	100.8
			1.5	370	.0002	0.7		0.1
			2.0	387	.0001	0.3		
			3.0	457	2.6E-5	-		
	Metribuzin/ Sencor	.84	1.0	92	.11	92.4	175	0.5
			1.5	387	.0001	0.1		
			2.0	417	6.5E-5	-		
			3.0	761	2.3E-8	-		
	Permethrin/ Pounce	1.12	1.0	>2061	-	-		
			1.5		-	-		
			2.0		-	-		
			3.0		-	-		

'LS-Analysis: Juab County (1/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	0.56	1.0	52	0.3775	211.4	36	5.9
			1.5	66	0.2904	162.6		4.5
			2.0	97	0.1625	91		2.5
			3.0	417	0.0004	0.2		6.2E-3
	Parathion/ Thiophos	0.56	1.0	2051	-			
			1.5	2051	-			
			2.0	2051	-			
			3.0	2051	-			
	Methidathion / Supracide	0.56	1.0	1832	5.5E-27			
			1.5	2015	-			
			2.0	2015	-			
			3.0	2015	-			
	Hexazinone/ Velpar	0.56	1.0				210	
			1.5					
			2.0					
			3.0					
Corn	2,4-D Amine	0.84	1.0	376	4.8E-12		70	
			1.5	699	9.4E-22			
			2.0	725	1.5E-22			
			3.0	817	2.5E-25			
	Fonofos/ Dyfonate	7.84	1.0	1528	2.2E-8		14	
			1.5	2045	-			
			2.0	2045	-			
			3.0	2045	-			
	Dicamba/ Banvel	0.28	1.0	56	0.0625	17.5	9	1.9
			1.5	87	0.0135	3.8		0.4
			2.0	346	3.6E-8			
			3.0	390	4.1E-9			
Small Grains	2,4-D Acid	0.84	1.0	30	0.1250		70	
			1.5	44	0.0474			
			2.0	379	3.9E-12			
			3.0	409	4.9E-13			
	Dicmba/ Banvel	0.56	1.0				9	
			1.5					
			2.0					
			3.0					

CMLS-Analysis: Juab County (2/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Dryland Winter Wheat	2,4-D Acid	0.84	1.0	>1655	-		70	
			1.5	>1655	-			
			2.0	>1655	-			
			3.0	>1655	-			
	Dicamba/Banvel	0.28	1.0	>1686	-		9	
			1.5	>1686	-			
			2.0	>1686	-			
			3.0	>1686	-			
Apples								
	Diazinon/ Dianon	1.12	1.0	119	0.0320	35.8	.63	56.9
			1.5	193	0.011	13		20.6
			2.0	422	5.8E-5			
			3.0	514	1E-6			
	Azinphos-Methyl/ Guthion	1.12	1.0	1909	4.3E-15			
			1.5	2030	-			
			2.0	2030	-			
			3.0	2030	-			

"LS-Analysis: Kane County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	2,4-DB Amine	1.68	1.0	29	0.1340	225.12		
			1.5	43	0.0508	85.34		
			2.0	60	0.0156	26.21		
			3.0	105	0.0007	1.18		
	Simazine/ Princep	0.56	1.0	96	0.4118	230.6	35	6.6
			1.5	378	0.0304	17		0.5
			2.0	408	0.0230	12.9		0.4
			3.0	456	0.0148	8.3		0.2
	Metribuzin/ Sencor, Lexone	1.12	1.0	66	0.2176	243.7	175	1.4
			1.5	82	0.1504	168.4		1.0
			2.0	113	0.0735	82.3		0.5
			3.0	144	0.0359	40.2		0.2
	Malathion/ Carbofos	1.4	1.0	1673	-			
			1.5	1673	-			
			2.0	1673	-			
			3.0	1673	-			

CMLS-Analysis: Millard County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	2,4-DB Amine	2.24	1.0	21	0.2333	522.59		
			1.5	37	0.0769	172.26		
			2.0	68	0.0090	20.16		
			3.0	113	0.0004	0.9		
	Carbofuran/	0.84	1.0	26	0.6144	516.1	36	14.3
	Furadan		1.5	56	0.3503	294.3		8.2
			2.0	73	0.2547	213.9		5.9
			3.0	377	0.0009	0.8		2.1E-2
	Hexazinone/	1.68	1.0	83	0.3833	643.9	210	3.1
	Velpar		1.2	97	0.3261	547.8		2.6
			2.0	113	0.2711	455.4		2.2
			3.0	158	0.1612	270.8		1.3
	Metribuzin/	1.12	1.0	83	0.1469	164.53	175	0.94
	Sencor, Lexone		1.5	113	0.0735	82.32		0.47
			2.0	127	0.0532	59.6		0.34
			3.0	189	0.0127	14.22		0.08
	Parathion/	0.56	1.0	497	2.1E-11	-		
	Thiophos		1.5	834	1.2E-18	-		
			2.0	1200	1.6E-26	-		
			3.0	-	-	-		
	Trifluralin/	2.24	1.0	888	0.0002	0.4	2	0.2
	Treflan		1.5	1270	3.5E-6	-	-	
			2.0	1953	4.0E-9	-		
			3.0	-	-			
	DCPA/	8.96	1.0	2071	-			3500
	Dacthal		1.5	2071	-			
			2.0	2071	-			
			3.0	2071	-			
Corn	Glyphosate/	1.12	1.0	2081	-			700
	Roundup		1.5	2081	-			
			2.0	2081	-			
			3.0	2081	-			
	Dicamba/	0.45	1.0	15	0.4758	214.1	9	23.8
	Banvel		1.5	27	0.2627	118.2		13.1
			2.0	57	0.0595	26.8		3.0
			3.0	133	0.0014	0.6		0.1

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Oxydemeton-Methyl/ Metasystox-R	0.56	1.0	40	0.2500	140		
			1.5	88	0.0474	26.5		
			2.0	102	0.0292	2.9E-2		
			3.0	361	3.7E-6	-		
	2,4-DB Ester	0.67	1.0	829	1.1E-25			
			1.5	1194	1.1E-36			
			2.0	1560	9.8E-45			
			3.0	>2046	-			
Small Grains	2,4-DB Ester	0.84	1.0	874	4.9E-27			
			1.5	1502	9.8E-45			
			2.0	1883	9.8E-45			
			3.0	>2066	-			
	Dicamba/ Banvel	0.14	1.0	20	0.3715	52.0	9	5.8
			1.5	41	0.1313	18.4		2.0
			2.0	57	0.0595	8.3		0.9
			3.0	385	5.3E-9	-		-
	Triallate/ Fargo	1.4	1.0	2066	-			
			1.5	2066	-			
			2.0	2066	-			
			3.0	2066	-			
	Glyphosate/ Roundup	1.12	1.0	2091	-		700	
			1.5	2091	-			
			2.0	2091	-			
			3.0	2091	-			
	MCPA/ Weedone	0.67	1.0	690	1.2E-11	-	3.6	
			1.5	1493	1.0E-15	-		
			2.0	1872	1.6E-19	-		
			3.0	2041	-	-		
	Chlorsulfuron/ Glean	0.02	1.0	32	0.4774	9.5		
			1.5	32	0.4774	9.5		
			2.0	46	0.3455	6.9		
			3.0	381	0.0002	4E-3		
Potatoes	Metribuzin/ Sencor, Lexone	0.84	1.0	27	0.5359	450.2	175	2.6
			1.5	36	0.4353	365.7		2.1
			2.0	57	0.2679	225.0		1.3
			3.0	97	0.1063	89.3		0.5

CMLS-Analysis: Millard County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Chlorothalonil/ Bravo	0.56	1.0	2003	1.7E-27	-	1.5	
			1.5	2003	-			
			2.0	2003	-			
			3.0	2003	-			
	Maneb/ Dithane	2.24	1.0	1403	6.4E-36			
			1.5	1799	1.1E-44			
			2.0	2003	-			
			3.0	2003	-			
Dryland Small Grains	Glyphosate/ Roundup	1.12	1.0	1928	-		700	
			1.5	1928	-			
			2.0	1928	-			
			3.0	1928	-			
	2,4-DB Ester	0.84	1.0	>1701	-			
			1.5	>1701	-			
			2.0	>1701	-			
			3.0	>1701	-			
	Dicamba/ Banvel	0.14	1.0	1701	-		9	
			1.5	1701	-			
			2.0	1701	-			
			3.0	1701	-			
	Chlorsulfuron/ Glean	0.02	1.0	1701	-			
			1.5	1701	-			
			2.0	1701	-			
			3.0	1701	-			
Aquatic	Petroleum Distillate Xylene							
	Prometon/Pramitol							

CMLS-Analysis: Morgan County (1/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/ Roundup	3.36	1.0	1706			700	
			1.5	1706				
			2.0	1706				
			3.0	1706				
	Hexazinone/ Velpar	1.68	1.0	46	0.578	987.5	210	4.7
			1.5	76	0.4156	678.21		3.32
			2.0	76	0.4156	698.21		3.32
			3.0	124	0.2387	401.02		1.91
	Malathion/ Carbofos	1.4	1.0	1665				
			1.5	1665				
			2.0	1665				
			3.0	1665				
Dry Land Wheat	2,4-D Acid	1.12	1.0	868	7.4E-27		70	
			1.5	1007	4.9E-31			
			2.0	1021	1.8E-31			
			3.0	1262	1E-38			
	Dicamba/ Banvel	0.14	1.0	608	8.4E-11		9	1.31E-12
			1.5	646	1.3E-14			
			2.0	873	1.7E-19			
			3.0	1014	1.6E-22			
	Carbaryl/ Sevin		1.0	2030			700	
			1.5	2030				
			2.0	2030				
			3.0	2030				
Irrigated Small Grains	2,4-D Acid	1.12	1.0	293	1.5E-9		70	
			1.5	370	7.3E-12			
			2.0	400	9.1E-13			
			3.0	559	1.5E-17			
	Dicamba/ Banvel	0.14	1.0	21	0.3536	49.5	9	5.5
			1.5	35	0.1768	24.75		2.75
			2.0	35	0.1768	24.75		2.75
			3.0	370	1.1E-8	1.54E-6		1.7E-7
	Carbaryl/ Sevin		1.0	1204	7E-4 5		700	
			1.5	1466	7E-45			
			2.0	1600	7E-45			
			3.0	2030				

CMLS-Analysis: Morgan County (2/2)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Potatoes	Disulfoton/ Disyston	4.48	1.0	>2061			0.3	
			1.5	>2061				
			2.0	>2061				
			3.0	>2061				
Corn	Atrazine/ Aatrex	2.69	1.0	657	0.0005	1.35	3	0.45
			1.5	746	0.0002			
			2.0	793	0.0001			
			3.0	983	1.2E-5			

.S-Analysis: Piute County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Ghyphosate/ Roundup	3.36	1.0	1686	-		700	
			1.5	1686	-			
			2.0	1686	-			
			3.0	1686	-			
	Carbofuran/ Furadan	1.12	1.0	73	0.2547	285.3	36	7.9
			1.5	87	0.1960	219.5		6.1
			2.0	376	0.0009	1		2.8E-2
			3.0	407	0.0005			
	Parathion	0.56	1.0	1660	-			
			1.5	1660	-			
			2.0	1660	-			
			3.0	1660	-			
Corn	2,4-D Acid	1.06	1.0	102	0.0009	2.9E-4	70	
			1.5	349	3.1E-11			
			2.0	361	1.4E-11			
			3.0	391	1.7E-12			
Small Grains	2,4-D Acid	1.06	1.0	40	0.0625		70	
			1.5	354	2.2E-11			
			2.0	375	5.1E-12			
			3.0	405	6.4E-13			

CMLS-Analysis: Rich County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/ Roundup	3.36	1.0	2061			700	
			1.5	2061				
			2.0	2061				
			3.0	2061				
	2,4-DB Amine	1.12	1.0	168	8.8E-6			
			1.5	346	3.8E-11			
			2.0	390	1.8E-12			
			3.0	580	3.5E-18			
Small Grains	2,4-D Acid	1.12	1.0	66	0.0103	11.54	70	0.01
			1.5	380	3.6E-12			
			2.0	431	1.1E-13			
			3.0	675	4.8E-21			
	Dicamba/ Banvel	0.10	1.0	36	0.1682	16.82	9	1.87
			1.5	66	0.0381	3.81		0.42
			2.0	66	0.0381	3.81		0.42
			3.0	431	5.4E-10	5.4E-8		6.E-9
	Glyphosate/ Roundup	4.2	1.0	2061			700	
			1.5	2061				
			2.0	2061				
			3.0	2061				
Small Fruits	Malathion/ Carbofos	1.5	1.0	2039				
			1.5	2039				
			2.0	2039				
			3.0	2039				
	Diazinon/ Dianon	1.7	1.0	379	0.0002	0.34	0.63	0.54
			1.5	585	1.3E-6			
			2.0	699	9.7E-8			
			3.0	724	5.4E-8			
	Diuron/ Karmex	2.24	1.0	1353	0.0573	128.35	14	9.17
			1.5	1693	0.0279	62.5		4.46
			2.0	1728	0.0259	58.02		4.14
			3.0	1928				

'.S-Analysis: Salt Lake County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/	3.36	1.0	2096	-		700	
	Roundup		1.5	2096	-			
			2.0	2096	-			
			3.0	2096	-			
	2,4-DB Amine	1.68	1.0	144	4.6E-5			
			1.5	321	2.2E-10			
			2.0	387	2.2E-12			
			3.0	448	3.3E-14			
	Sethoxydim/	0.47	1.0	318	7.2E-20			
	Poast		1.5	348	1.1E-21			
			2.0	379	1.5E-23			
			3.0	591	2.6E-36			
	Hexazinone/	1.68	1.0	41	0.6227	1046.14	210	4.98
	Velpar		1.5	72	0.4353	731.3		3.48
			2.0	200	0.0992	166.66		0.79
			3.0	345	0.0186	31.25		0.15
Small Grains	2,4-D Amine	1.12	1.0	740	5.3E-23		70	
			1.5	791	1.5E-24			
			2.0	894	1.2E-27			
			3.0	1105	5.4E-34			
	2,4-D Acid	1.12	1.0	47	0.0385		70	
			1.5	61	0.0146			
			2.0	396	1.2E-12			
			3.0	519	2.4E-16			
	Disulfoton/	1.12	1.0	2025	-		0.3	
	Disyston		1.5	2025	-			
			2.0	2025	-			
			3.0	2025	-			
Corn	Atrazine/	2.69	1.0	488	0.0036	9.68	3	3.23
	Aatrex		1.5	725	0.0002	0.54		0.18
			2.0	747	0.0002	0.54		0.18
			3.0	853	5.3E-5			
	Metolachlor/	3.36	1.0	725	1.2E-11		10	
	Dual		1.5	761	3.5E-12			
			2.0	822	4.2E-13			
			3.0	1080	5.6E-17			

CMLS-Analysis: Salt Lake County (2/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Carbofuran/ Furadan	1.12	1.0	36	0.5095	570.64	36	15.85
			1.5	66	0.2904	325.25		9.03
			2.0	128	0.0909	101.81		2.83
			3.0	375	0.0009	1.01		0.03
Dryland Winter Wheat	Chlorsulfuron/ Glean	0.027	1.0	641	3.7E-7			
			1.5	697	1E-7			
			2.0	954	2.7E-10			
			3.0	1107	7.8E-12			
	2,4-D Acid	1.12	1.0	695	1.2E-21		70	
			1.5	955	1.8E-29			
			2.0	1068	7.1E-33			
			3.0	1320	1.8E-40			
Vege-tables (cucumber)	Bensulide/ Prefar	6.72	1.0	2061	-			
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
Sweet Corn								
	EPTC/ Eptam	4.48	1.0	854	2.7E-9			
			1.5	1086	1.3E-11			
			2.0	1127	4.9E-12			
			3.0	1233	4.2E-13			
	Permethrin/ Pounce, Ambush	0.22	1.0	2000	-			
			1.5	2000	-			
			2.0	2000	-			
			3.0	2000	-			
	Alachlor/ Lasso	4.48	1.0	673	3.4E-15		1.5	
			1.5	751	7.1E-17			
			2.0	798	6.9E-18			
			3.0	1043	3.7E-23			
Tomatoes	Trifluralin/ Treflan	1.12	1.0	2066	-		2	
			1.5	2066	-			
			2.0	2066	-			
			3.0	2066	-			
Apples, Pears	Diazinon/ Dianon	9 gal	1.0	214	0.0071		0.63	
			1.5	432	4.6E-5			
			2.0	457	2.6E-5			
			3.0	576	1.7E-6			

'LS-Analysis: Salt Lake County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
	Azinphos-Methyl/ Guthion	2.80	1.0	2061	-			
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
	Triadimefon/ Bayleton	0.28	1.0	858	5E-13			
			1.5	1018	1.3E-15			
			2.0	1100	1.7E-16			
			3.0	1239	1.7E-18			

CMLS-Analysis: San Juan County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Irrigated Wheat	2,4-D Acid	1.12	1.0	46	0.0412		70	
			1.5	48	0.0359			
			2.0	128	0.0001			
			3.0	411	4.2E-13			
	Dicamba/ Banvel	0.14	1.0	32	0.2051			
			1.5	46	0.1025			
			2.0	84	0.0156			
			3.0	381	6.4E-9			
Dry Land Wheat	2,4-D Acid	1.12	1.0	473	5.8E-15		70	
			1.5	929	1.1E-28			
			2.0	>1676	-			
			3.0	>1676				
	Dicamba/ Banvel	0.14	1.0	136	0.0012		9	
			1.5	515	8.4E-12			
			2.0	1598	4.4E-35			
			3.0	>1676	-			

LS-Analysis: San Pete County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	2,4-D Ester	1.12	1.0	35	0.2195	245.84	70	3.51
			1.5	52	0.1051	117.71		1.68
			2.0	83	0.0274	30.69		0.44
			3.0	370	1.1E-7	1.23E-2		1.76E-6
	Carbofuran/ Furadan	1.12	1.0	61	0.3189	357.17	36	9.92
			1.5	77	0.2363	264.66		7.35
			2.0	91	0.1818	203.62		5.66
			3.0	139	0.0740	82.88		2.3
	Metribuzin/ Sencor, Lexone	1.12	1.0	87	0.1340	150.08	175	0.86
			1.5	101	0.0969	108.53		0.62
			2.0	118	0.0655	73.36		0.42
			3.0	163	0.0231	25.87		0.15
Corn	Phorate/ Thimet	1.73	1.0	2061	-			
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
	Atrazine/ Aatrex	2.24	1.0	386	0.0116	25.98	3	8.66
			1.5	447	0.0057	12.77		4.26
			2.0	478	0.0040	8.96		2.99
			3.0	767	0.0001	0.22		0.07
	2,4-D Acid	1.12	1.0	56	0.0206	23.07	70	0.33
			1.5	87	0.0005			
			2.0	334	8.8E-11			
			3.0	346	3.8E-11			
	Dicamba/ Banvel	0.56	1.0	42	0.1250	70	9	7.78
			1.5	73	0.0269	15.06		1.67
			2.0	87	0.0135	7.56		0.84
			3.0	346	3.6E-8			
	2,4-D Ester	1.12	1.0	35	0.2195	245.84	70	3.51
			1.5	35	0.2195	245.84		
			2.0	349	2-7E-7	3.02E-4		4.32E-6
			3.0	386	5.5E-8			
Crucifer Crops	Systox/Dementon		1.0	52	0.3008			
			1.5	66	0.2176			
			2.0	380	0.0002			
			3.0	417	6.5E-5			

CMLS-Analysis: Sevier County (1/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Hexazinone/ Velpar	1.12	1.0	88	0.3628	405.2	210	1.9
			1.5	102	0.3078	344.7		1.6
			2.0	118	0.2558	286.5		1.4
			3.0	163	0.1521	170.4		0.8
	Metribuzin/ Sencor, Lexone	0.84	1.0	102	0.0949	79.5	175	0.5
			1.5	118	0.0655	5.5		0.3
			2.0	149	0.0320	26.9		0.2
			3.0	194	0.0113	9.5		0.1
	Carbofuran/ Furadan	1.12	1.0	30	0.5701	638.5	36	17.7
			1.5	44	0.4385	491.1		13.6
			2.0	61	0.3189	357.2		9.9
			3.0	106	0.1373	153.8		4.3
	Parathion/ Thiophos	0.56	1.0	1331	-			
			1.5	1331	-			
			2.0	1331	-			
			3.0	1331	-			
Corn	Atrazine/ Aatrex	2.24	1.0	138	0.2031	454.9	3	151.6
			1.5	397	0.0102	22.8		7.6
			2.0	427	0.0072	16.1		5.4
			3.0	752	0.0002	0.4		0.1
	Dicamba/ Banvel	0.56	1.0	22	0.3365	188.4	9	20.9
			1.5	36	0.1682	94.2		10.5
			2.0	52	0.0762	42.7		4.7
			3.0	114	0.0035	2		0.2
	Trimethacarb/ Broot	1.73	1.0	380	3.6E-12	6.2E-9		
			1.5	406	6E-13			
			2.0	467	8.7E-15			
			3.0	772	5.8E-24			
	Fonofos/ Dyfonate	1.12	1.0	116	2.7E-6	3E-3	4	2.2E-4
			1.5	1228	6.9E-7			
			2.0	1563	1.4E-8			
			3.0	2066				
	Carbofuran/ Furadan	2.24	1.0	27	0.6030	135.7	36	37.5
			1.5	57	0.3438	770.1		21.4
			2.0	88	0.1923	430.8		12.0
			3.0	133	0.0828	185.5		5.2

CMLS-Analysis: Sevier County (2/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Phorate/	1.73	1.0	1518	8.4E-6			
	Thimet		1.5	1914	4.0E-7			
			2.0	2066				
						3.0	2066	
	Terbufos/	1.73	1.0	2066			0.18	
	Counter		1.5	2066				
			2.0	2066				
			3.0	2066				
Small	Triallate/	1.68	1.0	2096				
Grains	Fargo		1.5	2096				
			2.0	2096				
			3.0	2096				
	Barban/	0.42	1.0	46	0.3455	145.1		
	Carbyne		1.5	62	0.2387	100.3		
			2.0	76	0.1727	72.5		
			3.0	390	0.0001	4.2E-2		
	Diclofop/	1.4	1.0	2066				
	Hoelon		1.5	2066				
			2.0	2066				
			3.0	2066				
	Difenzoquat/	1.12	1.0	2066				
	Avenge		1.5	2066				
			2.0	2066				
			3.0	2066				
	2,4-D Acid	1.12	1.0	56	0.0206	70		
			1.5	39	1.7E-12			
			2.0	407	5.6E-12			
			3.0	735	7.5E-23			
Carrots	Trifluralin/	0.42	1.0	2010		2		
	Treflan		1.5	2010				
			2.0	2010				
			3.0	2010				
Fruit	Phosmet/	8.96	1.0	1078	5.9E-17			
Trees	Imidan		1.5	1201	8.4E-19			
			2.0	1522	1.2E-23			
			3.0	2039				

CMLS-Analysis: Sevier County (3/3)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Azinphos-Methyl/ Guthion	1.68	1.0	1430	1.7E-11			
			1.5	1967	9.6E-13			
			2.0	1962	1.7E-15			
			3.0	2039				

_S-Analysis: Summit County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/ Roundup	2.24	1.0	2061			700	
			1.5	2061				
			2.0	2061				
			3.0	2061				
	Promamide/ Kerb	1.96	1.0	1374	1.6E-14	3.14E-11	52	
			1.5	1770	1.7E-18			
			2.0	1877				
			3.0	1877				
	Hexazinone/ Velpar	1.4	1.0	203	0.0958	134.12	210	0.64
			1.5	217	0.0815	114.1		0.54
			2.0	247	0.0576	80.64		0.38
			3.0	437	0.0064	8.96		0.04
Small Grains	2,4-D Acid	1.12	1.0	35	0.0884	99.01	70	1.41
			1.5	370	7.3E-12			
			2.0	400	9.1E-13			
			3.0	735	7.5E-23			
	Carbofuran/ Furadan	0.28	1.0	35	0.5191	145.35	36	4.04
			1.5	370	0.0010	0.28		0.01
			2.0	400	0.0006			
			3.0	751	7.8E-7			

CMLS-Analysis: Tooele County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	EPTC/	4.48	1.0	817	6.3E-9	-	-	
	Eptam		1.5	899	1.5E-9	-	-	
			2.0	1166	2.0E-12	-	-	
			3.0	1518	5.4E-16	-	-	
	Paraquat/	1.12	1.0	>1737	-	-	-	
	Gramoxone		1.5	>1737	-	-	-	
			2.0	>1737	-	-	-	
			3.0	>1737	-	-	-	
	Parathion/	84	1.0	>2112	-	-	-	
	Thiophos		1.5	>2112	-	-	-	
			2.0	>2112	-	-	-	
			3.0	>2112	-	-	-	
	Simazine/	3.36	1.0	614	.0034	11.4	35	0.3
	Princep		1.5	645	.0026	8.7		0.2
			2.0	676	.0019	6.4		0.2
			3.0	979	.0001	0.3		-
Corn	Fonofos/	1.12	1.0	>2073	-	-	14	-
	Dyfonate		1.5	>2073	-	-		
			2.0	>2073	-	-		
			3.0	>2073	-	-		
	Terbufos/	3.75	1.0	>2073	-	-	0.18	
	Counter		1.5	>2073	-	-		
			2.0	>2073	-	-		
			3.0	>2073	-	-		
	Cyanazine/	3.36	1.0	505	2.5E-18	-	9.0	
	Bladex		1.5	794	1.1E-12	-		
			2.0	839	2.4E-13	-		
			3.0	1129	1.0E-17	-		
Small Grains	2,4-D Amine	.56	1.0	421	2.1E-13	-	70	
			1.5	735	7.5E-23	-		
			2.0	772	5.8E-24	-		
			3.0	868	7.4E-27	-		
	MCPA/	.84	1.0	>2066	-	-	3.6	
	Weedone		1.5	>2066	-	-		
			2.0	>2066	-	-		
			3.0	>2066	-	-		

'LS-Analysis: Uintah County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Hexazinone/ Velpar	1.12	1.0	47	0.5810	650.72	210	3.1
			1.5	77	0.4108	460.1		2.19
			2.0	91	0.3495	391.44		1.86
			3.0	122	0.2443	273.62		1.3
	Metribuzin/ Sencor, Lexone	0.84	1.0	77	0.1688	141.79	175	0.81
			1.5	91	0.1221	102.56		0.59
			2.0	108	0.0825	69.3		0.40
			3.0	412	7.3E-5	0.06		3.5E-4
	Parathion/ Thiophos	0.56	1.0	>1660				
			1.5	>1660				
			2.0	>1660				
			3.0	>1660				
	Malathion/ Carbofos	1.4	1.0	1660				
			1.5	1660				
			2.0	1660				
			3.0	1660				
Corn	Atrazine/ Aatrex	2.52	1.0	416	0.0082	20.66	3	6.89
			1.5	458	0.0050	12.6		4.2
			2.0	503	0.0030	7.56		2.52
			3.0	807	8.9E-5	0.22		0.07
	2,4-D Acid	0.84	1.0	66	0.0103	8.65	70	0.12
			1.5	97	0.0012			
			2.0	344	4.4E-11			
			3.0	370	7.3E-12			
Small Grains	2,4-D Acid	1.06	1.0	32	0.1088	115.33	70	1.65
			1.5	46	0.0412	43.67		0.62
			2.0	360	1.5E-11			
			3.0	397	1.1E-12			

CMLS-Analysis: Utah County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Quantity (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/ Roundup	3.36	1.0	>2096	-	-	700	
			1.5	>2096	-			
			2.0	>2096	-			
			3.0	>2096	-			
Corn	Atrazine/ Aatrex	1.68	1.0	401	.0097	16.3	3.0	5.4
			1.5	423	.0075	12.6		4.2
			2.0	467	.0045	7.6		2.5
			3.0	766	.0001	0.2		0.1
	2,4-D Acid	.28	1.0	63	.0127	3.6	70	0.1
			1.5	63	.0127	3.6		0.1
			2.0	77	.0084	2.4		-
			3.0	107	.0006	0.2		-
	Diazinon/ Dianon	1.12	1.0	92	.1194	134	0.63	212
			1.5	316	.0007	0.8		1.2
			2.0	371	.0002	0.2		0.4
			3.0	426	5.3E-5	0.1		0.1
Small Grains	2,4-D Acid	.56	1.0	32	.1088	61	70	0.9
			1.5	46	.0412	23		0.3
			2.0	360	1.5E-11	-		-
			3.0	397	1.1E-12	-		-
	Difenzoquat/ Avenge	.84	1.0	>2056	-			
			1.5	>2056	-			
			2.0	>2056	-			
			3.0	>2056	-			
	Dicamba/ Banvel	.14	1.0	10	.6095	85	9.0	9.5
			1.5	31	.2155	30		3.4
			2.0	47	.0976	13.7		1.5
			3.0	61	.0488	6.8		0.8
Dry Land Wheat	Chlorsulfuron/ Glean	.018	1.0	524	5.5E-6	-		
			1.5	647	3.2E-7	-		
			2.0	869	1.9E-9	-		
			3.0	1038	3.8E-11	-		
Orchards	Diazinon/ Dianon	5.6	1.0	94	.114	638	0.63	1013
			1.5	138	.041	230		364
			2.0	350	.0003	1.7		2.7
			3.0	442	3.7E-5	0.02		-

LS-Analysis: Wasatch County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	1.12	1.0	203	0.0223	24.98	36	0.69
			1.5	356	0.0013	1.46		0.04
			2.0	370	0.0010	1.12		
			3.0	431	0.0003			
Small Grains	Glyphosate/ Roundup	2.23	1.0	1943			700	
			1.5	1943				
			2.0	1943				
			3.0	1943				

CMLS-Analysis: Washington County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Hexazinone	1.5	1.0	100	0.315	472.5	210	2.25
			1.5	117	0.258	338.2		1.849
			2.0	117	0.258	338.2		1.849
			3.0	147	0.183	274.5		1.307
	Metribuzin	1.0	1.0	117	0.067	67	175	0.3829
			1.5	117	0.067	67		0.3829
			2.0	131	0.0485	48.5		0.2771
			3.0	161	0.0242	24.2		0.1383
	Chlorpyrifos	0.25	1.0	1735				
			1.5	1735				
			2.0	1735				
			3.0	1735				
	Parathion	0.5	1.0	487	3.4E-11	1.7E-8		
			1.5	821	2.2E-18	1.1E-15		
			2.0	1171	6.6E-26	3.3E-23		
			3.0	1735				
Orchards	Aziaphos-Methyl	3.0	1.0	778	1.4E-6	4.2E-3		
			1.2	1093	5.9E-9	1.77E-5		
			2.0	1560	1.8E-12	5.4E-9		
			3.0	2068				

MLS-Analysis: Wayne County (1/1)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent. (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Glyphosate/ Roundup	3.36	1.0	1543	-		700	
			1.5	1543	-			
			2.0	1543	-			
			3.0	1543	-			
	Carbofuran/ Furadan	1.12	1.0	46	0.4224	473.1	36	13.1
			1.5	60	0.3050	364.0		10.1
			2.0	77	0.2363	264.7		7.4
			3.0	380	0.0008	0.9		2.5E-2
	Parathion/ Thiophos	0.56	1.0	1644	8.3E-33			
			1.5	1644	-			
			2.0	1644	-			
			3.0	1644	-			
Corn	Dicamba/ Banvel	0.56	1.0	26	0.2360	154.6	9	17.2
			1.5	71	0.0297	16.6		1.8
			2.0	102	0.0064	3.6		0.4
			3.0	349	3.1E-8	-		-
	2,4-D Acid	1.12	1.0	57	0.0192		70	
			1.5	96	0.0013			
			2.0	102	0.0009			
			3.0	361	1.4E-11			
Small Grains	2,4-D Acid	1.12	1.0	25	0.1768		70	
			1.5	25	0.1768			
			2.0	339	6.2E-11			
			3.0	376	4.8E-12			

CMLS-Analysis: Weber County (1/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Alfalfa	Carbofuran/ Furadan	1.12	1.0	115	0.1160	129.92	36	3.61
			1.5	358	0.0012	1.34	36	0.04
			2.0	592	1.5E-5			
			3.0	843	1.4E-7			
	Metribuzin/ Sencor, Lexone	1.12	1.0	123	0.0583	65.3	175	0.37
			1.5	168	0.0206	23.07		0.13
			2.0	533	4.5E-6			
			3.0	884	1.3E-9			
	Hexazinone/ Velpar	1.68	1.0	88	0.3618	607.82	210	2.89
			1.5	62	0.3078	517.1		2.46
			2.0	221	0.0778	130.7		0.62
			3.0	497	0.0032	5.38		0.03
Corn	Fonofos/ Dyfonate	4.48	1.0	1335	-			
			1.5	1335	-			
			2.0	1335	-			
			3.0	1335	-			
	Metolachlor/ Dual	3.36	1.0	432	0.1895	636.72	210	63.67
			1.5	781	0.0494	165.98		16.6
			2.0	1521	0.0030	10.08		1.01
			3.0	2076	-			
Winter Wheat	2,4-D Acid	1.40	1.0	22	0.2176	304.64	70	4.35
			1.5	36	0.0825	115.5		1.65
			2.0	36	0.0825	115.5		1.65
			3.0	66	0.0103	14.42		0.21
Onions	DCPA/ Dacthal	11.2	1.0	1011	-		3500	
			1.5	1011	-			
			2.0	1011	-			
			3.0	1011	-			
	Oyxfluorfen/ Goal	0.56	1.0	2061	-			
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
	Methyl-Parathion/ Metafos Penncap-M	0.56	1.0	244	3.3E-25			
			1.5	289	1E-29			
			2.0	320	7.8E-33			
			3.0	372	4.7E-38			

CMLS-Analysis: Weber County (2/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	2,4-D Acid	1.4	1.0	40	0.0625		70	
			1.5	375	5.1E-12			
			2.0	405	6.4E-13			
			3.0	648	3.1E-20			
Green Beans	Trifluralin/ Treflan	0.84	1.0	1511	3.2E-7		2	
			1.5	2012	2.2E-9			
			2.0	2061	-			
			3.0	2061	-			
	EPTC/ EPTAM	3.36	1.0	381	0.0002	0.67		
			1.5	400	9.7E-5			
			2.0	745	3.3E-8			
			3.0	1085	1.3E-11			
	Bentazone/ Basagran	0.84	1.0	24	0.1895	159.18		
			1.5	280	3.7E-9			
			2.0	339	6.2E-11			
			3.0	359	1.6E-11			
	Malathion/ Carbofos	1.68	1.0	2005	-			
			1.5	2005	-			
			2.0	2005	-			
			3.0	2005	-			
Apples, Pears	Methidathion/ Supracide		1.0	2016	1.3E-29			
			1.5	2107	-			
			2.0	2107	-			
			3.0	2107	-			
	Azinphos-Methyl/ Guthion		1.0	2020	-			
			1.5	2020	-			
			2.0	2020	-			
			3.0	2020	-			
	Benomyl/ Benlate		1.0	2015	-			
			1.5	2015	-			
			2.0	2015	-			
			3.0	2015	-			

CMLS-Analysis: Weber County (3/4)

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
Peaches Apricots								
	Endosulfan/ Thiodan							
	Chlorpyrifos/ Lorsban							
	Chlorothalonil/ Bravo							
Spring Barley	Carbaryl/ Sevin		1.0	740	1.5E-32		700	
			1.5	1084	7E-45			
			2.0	1471	7E-45			
			3.0	2035	-			
Green Beans	Trifluralin/ Treflan	0.84	1.0	2061	-		2	
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
Onions	DCPA/ Dacthal	11.2	1.0	1376	-		3500	
			1.5	1376	-			
			2.0	1376	-			
			3.0	1376	-			
	Mevinphos/ Phosdrin	0.56	1.0	133	4.5E-14			
			1.5	245	236E-25			
			2.0	299	9.9E-31			
			3.0	320	7.8E-33			
Green Beans	Trifluralin/ Treflan	0.84	1.0	2061	-		2	
			1.5	2061	-			
			2.0	2061	-			
			3.0	2061	-			
Alfalfa	Carbofuran/ Furadan	1.12	1.0	94	0.1719	192.53	36	5.35
			1.5	104	0.1425	159.6		4.43
			2.0	358	0.0012	1.34		0.04
			3.0	402	0.0005	0.56		0.02

Crop	Pesticide (Common/Trade)	Quantity (kg/ha)	Depth (m)	Time (days)	Rel. Amount	Concent (ppb)	Health Advise(ppb)	Ratio
	Metribuzin/ Sencor, Lexone	1.12	1.0	93	0.1166	130.59	175	0.75
			1.5	107	0.0844	94.53		0.54
			2.0	168	0.0206	23.07		0.13
			3.0	383	0.0001	0.11		
	Hexazinone/ Velpar	1.12	1.0	88	0.3618	405.22	210	1.93
			1.5	88	0.3618	405.22		1.93
			2.0	118	0.2558	286.5		1.36
			3.0	163	0.1521	170.35		0.81
Corn	Fonofos/ Dyfonate	4.48	1.0	757	0.002	0.90	14	0.06
			1.5	863	4.7E-5			
			2.0	1335	-			
			3.0	1335	-			
	Metolachlor/ Dual	3.36	1.0	129	0.6085	2044.56	10	204.46
			1.5	380	0.2315	777.84		77.78
			2.0	477	0.1593	535.25		53.52
			3.0	797	0.0465	156.24		15.62

APPENDIX B

Surveys Used in Simulation of Pesticide Movement in Utah

by

Howard M. Deer

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/2-7	Hexazinone/H	0.5-1.0	March/1	L
	and			
	Carbofuran/I	0.5	May/3	F
	or			
	Methyl Parathion/I	0.5	May/4	E
	or			
	Chlorpyrifos/I	0.5-1.0	May/4	WP
Field Corn/8-9	Atrazine/H	2.0	Preplant, Preemergent, or Post Emergent	F or WP
	and			
	2,4-D/H	0.5-0.75 a.e.	June/3	L
	and			
	Carbofuran/I	1.0	Planting	G
Small Grains/10	2,4-D/H	0.5 a.e.	Spring	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

County: Box Elder (1 of 4)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Pronamide/H	1.0	June	WP
	and			
	2,4-DB/H	1.0 a.e.	May-June	L
	or			
	EPTC/H	3.0	March	E
Alfalfa/2	Metribuzin/H	0.75	October or March	F
	and			
	Methyl Parathion/I	0.5	May	F
	or			
	Carbofuran/I	0.75	May	F
Alfalfa/3-5	None			
Field Corn/6-7	Alachlor/H	3.0	March-April	E
	or			
	Cyanazine/H	2.0	March-April	F
	or			
	Atrazine/H	2.0	Preplant, Preemergent or Post Emergent	WP
	or			
	2,4-D/H	0.5-0.75 a.e.	June	L
	and			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Field Corn/6-7 continued	Oxydemeton-Methyl/I	0.5	July	E or L
	and/or			
	Propargite/A	1.7	July	E
	and/or			
	Disulfoton/I	0.75	July	E
	and			
	Carbofuran/I	1.0	Planting	F or G
	or			
	Fonofos/I	1.0	Planting	E or G
Fall Wheat or Barley/ 9	Disulfoton/I	0.25-1.0	Planting	E or G
	or			
	Dimethoate/I (Wheat)	0.25-0.375	Planting	E
	and			
	2,4-D/H	0.24-0.95 a.e.	May-June	L
	or			
	Bromoxynil/H	0.25-0.5	May-June	L
	and			
	Triallate/H	1.25	Fall or Spring	E
	or			
	Diclofop/H	1.0	Fall or Spring	E

A = Acaricide
H = Herbicide
= Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
or				
Spring Wheat/8-9	Same pesticide applications, but different application dates.			
Onions/10	DCPA/H	10.0	Preplant	F or WP
	and/or			
	Oxyfluorfen/H	0.12-0.25	May	E
	and/or			
	Bromoxynil/H	0.25-0.375	May	L
	and			
(Each insecticide is applied during one season for a total of at least 3 applications)	Parathion/I	0.75	June, July, or August	E
	or			
	Azinphos-Methyl/I	0.5-0.75	June, July, or August	WP
	or			
	Methyl Parathion/I	0.5	June, July, or August	F
Dry and Snap Beans	Trifluralin/H	0.5	April, May or June	E
	and			
	EPTC/H	3.0	April, May or June	E
	or			
	Metolachlor/H	2.0	April, May or June	E
	or			
	Bentazon/H	1.0	July	L
	and			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Dry and Snap Beans continued	Fenvalerate/I	0.112	July, August, or September	E
	and			
	Benomyl/F	0.75	July or August	WP
Dryland Small Grains/1	Disulfoton/I	0.25-1.0	Planting	E or G
	or			
	Dimethoate/I (Wheat)	0.25-0.375	Planting	E
Fallow/2	None			
Apples, Cherries, and Peaches	Dormant Oil/I	6-9 gal/acre	April/1	E
	and			
	Benomyl/F	0.5	May 3 applications	WP
	and			
	Azinphos-Methyl/I	0.75-1.25	May/5-August/2 4 applications	WP
	or			
	Phosmet/I (Peaches)	4.0	June and July 2 applications	WP

F = Fungicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
G = Granular
WP = Wettable Powder

County: Cache (1 of 4)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1-6 (About 20% treated with herbicide)	Hexazinone/H	0.5-1.5	November or April	L
	or			
	Metribuzin/H	0.375-1.0	November or April	F
	and			
(About 10-20% treated with insecticide)	Parathion/I	0.25-0.5	May/5-June/1	E
	or			
	Carbofuran/I	0.5-1.0	May/1-2	F
	or			
	Malathion/I	1.25	June/3	E
Small Grains/7-9 (About 90% treated with herb-cide)	2,4-D/H	0.24-0.95 a.e.	May-June	L
	and			
	Dicamba/H	0.09-0.125	May-June	L
	or			
	Chlorsulfuron/H	0.019	April	F
	or			
	Metsulfuron/H	0.004	April	F
	and			
(About 50% also treated with Diclofop, Triallate or Difen-zoquat)	Diclofop/H	0.75-1.25	Fall or Spring	E
	or			
	Triallate/H	1.0-1.5	Fall or Spring	E
	or			
	Difenzoquat/H	0.625-1.0	Fall or Spring	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Field Corn/10 (About 95% treated with herbicide)	Atrazine/H	1.2-2.4	PP, PEE or POE	L or WP
	or			
	Cyanazine/H	1.25-2.0	PP or PEE	F
	or			
	Alachlor/H	2.5-4.0	PP or PEE	E
	or			
	Metolachlor/H	1.5-3.0	PP or PEE	E
	or			
	EPTC plus Safener/H	3.0-6.0	Preplant	E
	and			
	2,4-D/H	0.5-0.75 a.e.	Post Emergent	L
Dryland Wheat/1	2,4-D/H	0.24-0.95 a.e.	May-June	L
	and			
	Chlorsulfuron/H	0.019	April	F
	or			
	Metsulfuron/H	0.004	April	F
Fallow/2	None			
Field Corn (About 95% treated with herbicide)	Atrazine/H	1.2-2.4	PP, PEE or POE	L or WP
	or			
	Cyanazine/H	1.25-2.0	PP or PEE	F

H = Herbicide
I = Insecticide
"" = Preplant
: = Preemergent
POE = Post Emergent

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Field Corn continued	or			
	Alachlor/H	2.5-4.0	PP or PEE	E
	or			
	Metolachlor/H	1.5-3.0	PP or PEE	E
	or			
	EPTC plus Safener/H	3.0-6.0	Preplant	E
	and			
	2,4-D/H	0.5-0.75 a.e.	Post Emergent	L
	and			
(About 40-50% treated with insecticide)	Fonofos/I	0.75-1.0	May/1	G
	or			
	Phorate/I	1.2oz/1000 row ft	May/1	G
	or			
	Fensulfothion/I	0.5-1.0	May/1	G
Snap Beans, Melons, Tomatoes, or Sweet Corn	Trifluralin/H	0.5-0.75	Preplant	E
	or			
	EPTC/H	3.0-4.0	Preplant	E
Apples	Azinphos-Methyl/I	0.5-1.0	June, July, August 3 applications	WP
	and/or			
	Parathion/I	0.75-1.0	June, July, August 3 applications	WP
	and/or			

H = Herbicide
I = Insecticide
PP = Preplant
PEE = Preemergent
POE = Post Emergent

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
G = Granular
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Apples continued	Diazinon/I	2.0-3.0	June, July, August 3 applications	WP
	and/or			
	Phosmet/I	2.0-3.0	June and July 2 applications	WP
	and/or			
	Phosalone/I	1.0-1.5	June and July 2 applications	WP
	and/or			
	Propargite/A	1.5	June, July, August 3 applications	WP
Cherries	Diazinon/I	1.0-2.0	June, July, August 6-8 applications	WP
	and/or			
	Dimethoate/I	1.0-2.0	June, July, August 3 applications	E
	and/or			
	Malathion/I	2.0	June, July, August 6-8 applications	WP

A = Acaricide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
WP = Wettable Powder

County: Carbon (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1-6	Carbofuran/I	0.5-1.0	May/2-3 or June/1	F
	or			
	Methidathion/I	0.25	May/2	E
	or			
	Chlorpyrifos/I	0.5	April/4	WP
	or			
	Parathion/I	0.5	June/1	E
Field Corn/7-9	2,4-D/H	0.5-0.75 a.e.	May-June	L
Alfalfa/1-5	Carbofuran/I	0.5	June/1	F
Oats/6-7	2,4-D/H	0.24-0.95 a.e.	June/1	L
	and			
	Dicamba/H	0.09-0.125	June/1	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

County: Daggett (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/ 1-10	Carbofuran/I	0.25-1.0	June	F
	or			
	Methyl Parathion/I	0.5	June	E
	or			
	Malathion/I	1.25	June	E
Small Grains/ 11-12	None			

I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable

County: Davis (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Onions/1	DCPA/H	10.0	April/1	WP
	or			
	Oxyfluorfen/H	0.12-0.25	May/1	E
	and			
	Fluazifop/H	0.1-0.25	May/1	E
	and			
	Methyl Parathion/I	0.5	June, July or August	F
	or			
	Parathion/I	0.75	June, July or August	E
	or			
	Azinphos-Methyl/I	0.5-0.75	June, July or August	WP
Fall Wheat/2	Triallate/H	1.0	September/4	E
	or			
	Difenzoquat/H	1.0	April/2	L
	and			
	2,4-D/H	0.5 a.e.	May/2	L
	and			
	Carbaryl/I	0.5	June/1	L
	or			
	Malathion/I	0.25-0.5	June/1	E
Snap Beans/3 (Two Crops)	Trifluralin/H	0.5-0.75	April/2 and July/2	E
	or			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Snap Beans/ 3 (Two Crops) continued	Bentazon/H	0.75-1.0	May/2 and August/2	L
	and			
	Malathion/I	1.0	July/1 and September/2	E
Potatoes/1 (Small Grains Alternat-ively)	Metolachlor/H	2.0	May/1	E
	or			
	Metribuzin/H	0.5	May/1	F
	and			
	Azinphos-Methyl/I	0.375	June/2	WP
	and			
	Aldicarb/I,N	2.0	April/4	G
Field Corn/2	Melotachlor/H	2.0	May/1	E
	or			
	Alachlor/H	3.0	May/1	E
	or			
	Cyanazine/H	0.6	May/1	L
Alfalfa/3	None			
Alfalfa/ 4-8	Hexazinone/H	1.0	April/1	L
	or			
	Sethoxydim/H	0.375	April/4	E
	and			
	Carbofuran/I	0.5	June/3	F

H = Herbicide
I = Insecticide
= Nematicide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

County: Duchesne (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1-5	2,4-DB/H	0.5-1.5 a.e.	May/4	L
	and			
	Malathion/I	0.94-1.25	June	E
	and/or			
	Methyl Parathion/I	0.0625-0.125	June	E
Field Corn/6-7	Atrazine/H	1.2-2.4	April/3	L or WP
	and/or			
	2,4-D/H	0.5-0.75 a.e.	May/1	L
	or			
	EPTC plus Safener/H	3.0-4.0	April/3	E
	and/or			
	Diazinon/I	1.0-2.0	Planting	G or WP
Small Grains/8	2,4-D/H	0.24-0.95 a.e.	May/5 or June/1-2	L
	and/or			
	Dicamba/H	0.09-0.125	May/3-5 or June/1-2	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
G = Granular
L = Liquid
WP = Wettable Powder

County: Emery (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	1.5 a.e.	May/1	L
Alfalfa/2-7	Methidathion/I	0.75	June/1	E
	or			
	Carbofuran/I	0.25-1.0	May	F
Field Corn/8-9	2,4-D/H	0.5 a.e.	July/2	L
	and/or			
	EPTC plus Safener/H	3.0	May/2	E
Small Grains/10	None			
Alfalfa/1	Glyphosate/H	1.5 a.e.	May/1	L
Alfalfa/2-5	Methidathion/I	0.75	June/1	E
	or			
	Carbofuran/I	0.25-1.0	May	F
Melons/6-7	Naptalam/H	1.5-3.0	Preplant	L
	and/or			
(Only occasionally used)	Bensulide/H	4.0-6.0	Preplant	E
	and/or			
	Trifluralin/H	0.5-0.75	Post Emergent	E
	and/or			
	Chlorothalonil/F	1.3	May-June	WP
Peaches and Apples	Azinphos-Methyl/I	0.4	May, June, July, and August 4 applications	WP
	and			
	Glyphosate/H	0.75-3.75 a.e.	June/1	L

F = Fungicide
H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

County: Garfield (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	2.0-3.0 a.e.	Preplant	L
Alfalfa/2-5	None			
Alfalfa/6 (About 200 acres treated)	Hexazinone/H	1.0	Fall or Spring	L
Alfalfa/ 6-10 (About 75% in Panguitch Valley treated)	Parathion/I or Carbofuran/I	0.25 0.25	June June	E F
Small Grains/ 11-12	None			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1-7	Hexazinone/H	0.5-1.5	March/2	L
	or			
(Very little herbicide usage)	Metribuzin/H	0.375-1.0	March/2	L
	or			
	Pronamide/H	0.75-1.0	Fall	L
	or			
	Sethoxydim/H	0.19-0.47	Spring, Summer or Fall	E
	and			
	Malathion/I	1.0-1.5	As Needed	E
Small Grains/8-9	2,4-D/H	0.24-0.95 a.e.	Spring	L
	and/or			
	Dicamba/H	0.09-0.125	Fall or Spring	L
Field Corn/10-11	Atrazine/H	1.2-2.4	Preplant, Preemergent, or Post Emergent	L
	or			
	2,4-D/H	0.5-0.75 a.e.	Post Emergent	L
	and			
or	Cyanazine/H	1.25-3.0	Preemergent	L
Melons/ 10-11	Bensulide/H	4.0-6.0	May/1	E
	and			
	Naptalam/H	1.5-3.0	May/1	L
	and			

= Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
L = Liquid

County: Grand (2 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Melons/ 10-11 continued	Trifluralin/H	0.5-0.75	June/1	E
	and			
	Glyphosate/H	2.0 a.e.	October/1	L

H = Herbicide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
L = Liquid

unty: Iron (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/ 2-10	Metribuzin/H	0.5	Spring or Fall	F
	or			
	Hexazinone/H	1.0	Spring or Fall	L
	or			
	2,4-DB/H	0.5-1.5 a.e.	Spring	L
	or			
	None			
	and			
	Parathion/I	1.0	June/1	E
all ..ains/11-12	2,4-D/H	0.5 a.e.	Spring	L
	and			
	Parathion/I	1.0	June/1	E
Potatoes/ 1-4	Metribuzin/H	0.75	May	F
	and			
	Aldicarb/I,N	2.0-3.0	May/1-2	G
Alfalfa/ 5-10	Metribuzin/H	0.5	Spring or Fall	F
	or			

H = Herbicide
I = Insecticide
N = Nematicide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

County: Iron (2 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
	Hexazinone/H	1.0	Spring or Fall	L
	or			
	2,4-DB/H	0.5-1.5 a.e.	Spring	L
Small Grains/11-12	2,4-D/H	0.5 a.e.	Spring	L
	and			
	Parathion/I	1.0	June/1	E
Potatoes	Metribuzin/H	0.75	May	F
	and			
	Aldicarb/I,N	2.0-3.0	May/1-2	G

H = Herbicide
I = Insecticide
N = Nematicide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

County: Juab (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/ 2-8	Hexazinone/H	0.5	March/1	L
	and			
	Carbofuran/I	0.25-0.5	May/2	F
	or			
	Methyl Parathion/I	0.25-0.5	May/3	E
Field Corn/9-11	2,4-D/H	0.5-0.75 a.e.	June/3	L
	and/or			
	Dicamba/H	0.25-0.5	June/2	L
	and			
	Fonofos/I	0.75	May/4	G
Small Grains/ 12-13	2,4-D/H	0.5-0.75 a.e.	May/5-June/1	L
	and			
	Dicamba/H	0.25-0.5	May/5-June/1	L
Dryland Small Grains/1	2,4-D/H	0.5-0.75 a.e.	May/3	L
	and			
	Dicamba/H	0.125-0.25	May/3	L
	and/or			
	Chlorsulfuron/H	0.01-0.02	Fall	F
Fallow/2	None			
Apples	Diazinon/I	4.0-6.0	April/1	WP
	and			
	Azinphos-Methyl/I	1.0	May/2, June/2, July/2, August/2 4 applications	WP

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

County: Kane (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/ 2-10 (Metribuzin used near Kanab; others near Mt. Carmel)	Metribuzin/H	0.375-1.0	Spring	L
	and			
	Malathion/I	0.5	May/3 or June/1	E
	and			
	2,4-DB/H	0.5 a.e.	May/2	L
	or			
	Simazine/H	0.8-1.6	Spring	WP
Small Grains/ 11-12	None			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
L = Liquid
WP = Wettable Powder

County: Millard (1 of 3)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1 (2,4-D and Dicamba applied in previous year)	2,4-D/H	0.75 a.e.	August/3	L
	and			
	Dicamba/H	0.10	August/3	L
	and			
	2,4-DB/H	1.20 a.e.	May/4	L
	and			
	Carbofuran/I	0.75	May/3	F
Alfalfa/2-7	Hexazinone/H	1.0-2.0	March/2	L
	or			
	Metribuzin/H	0.4-1.0	March/2	F
	and			
	Carbofuran/I	0.75	May/3	F
	or			
	Parathion/I	0.5	May/3	E
	and			
(In seed alfalfa for dodder control)				
	Trifluralin/H	2.0	March/2-3	E
	or			
	DCPA/H	8.0	April/4	WP

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

County: Millard (2 of 3)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Small Grains/8	MCPA/H	0.60 a.e.	May/4	L
	or			
	2,4-D/H	0.75 a.e.	May/1	L
	and			
	Dicamba/H	0.1	May/1	L
	and			
	Triallate/H	1.25	October/2 or May/1	E
	or			
	Chlorsulfuron/H	0.02	May	F
Field Corn/9	Glyphosate/H	1.0 a.e.	Preplant	L
	and			
	2,4-D/H	0.6 a.e.	May/4	L
	and			
	Dicamba/H	0.4	May/1-3	L
	and			
	Oxydemeton-Methyl/I	1.5-2.0	July/1	E
Potatoes/10	Metribuzin/H	0.75	May/2	F
	and			
	Chlorothalonil/F	1.5-2.0	July-August	WP
	and			
	Maneb/F	2.0	July-August	WP

F = Fungicide
H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Dryland Small Grains/1	2,4-D/H	0.75 a.e.	May/1	L
	and			
	Dicamba/H	0.1	May/1	L
	or			
	Chlorsulfuron/H	0.02	May/4	F
Fallow/2	Glyphosate/H	1.0 a.e.	September	L

= Herbicide

a.i. = active ingredient
a.e. = acid equivalent

F = Flowable
L = Liquid

County: Morgan (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	0.75-2.0 a.e.	April/4	L
Alfalfa/2-7	Hexazinone/H	0.5-1.5	April/4	L
	and			
	Malathion/I	1.0-1.5	June/2	E
Barley or Oats/8-9	2,4-D/H	0.5 a.e.	June/2	L
	and/or			
	Dicamba/H	0.5	June/2	L
	and			
	Carbofuran/I	0.25	June/2	F
Dryland Alfalfa/1	Glyphosate/H	0.75-3.0 a.e.	September/2	L
Dryland Alfalfa/2-9	Malathion/I	1.0-1.5	June/2	E
Dryland Wheat/10-11	2,4-D/H	0.5 a.e.	June/2	L
	and/or			
	Dicamba/H	0.5	June/2	L
	and			
	Carbaryl/I	0.25	June/2	L
Field Corn	Atrazine/H	2.0-2.4	May/4	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

ınty: Piute (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	0.125 a.e.	May/1	L
Alfalfa/2	Parathion/I	0.375-0.5	June/3	E
	or			
	Carbofuran/I	0.125-0.25	June/3	F
Alfalfa/3-4	None			
Alfalfa/5	Parathion/I	0.375-0.5	June/3	E
	or			
	Carbofuran/I	0.125-0.25	June/3	F
Alfalfa/6	None			
Small Grains/ 3	2,4-D/H	1.0 a.e.	June/2	L
Field Corn/9	2,4-D/H	1.0 a.e.	June	L

= Herbicide
= Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

County: Rich (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	1.0 a.e.	Preplant	L
	and			
	2,4-D/H	0.75 a.e.	Preplant	L
Alfalfa/ 2-10	None			
Small Grains/ 11-12	2,4-D/H	0.75 a.e.	May/2	L
	and/or			
	Dicamba/H	1.0-1.5	May/2	L
Dryland Small Grains/1-4	2,4-D/H	0.75 a.e.	May/2	L
	and/or			
	Dicamba/H	1.0-1.5	May/2	L
Fallow/5	Glyphosate/H	0.5-1.0 a.e.	May/2	L
Small Fruits	Malathion/I	1.75	As Needed	E
	or			
	Diazinon/I	1.0	As Needed	E or WP
	and			
	Diuron/H	2.0	September/3	WP

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
L = Liquid
WP = Wettable Powder

County: Salt Lake (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	2.0-3.0 a.e.	April/1	L
	or			
	2,4-DB/H	0.5-1.5 a.e.	May-June	L
	or			
	Sethoxydim/H	0.188-0.469	July-August	E
Alfalfa/2-6	Sethoxydim/H	0.188-0.469	July-August	E
	or			
	2,4-DB/H	0.5-1.5 a.e.	July-August	L
	or			
	Hexazinone/H	0.5-1.5	Spring or Fall	L
Small Grains/7-8	2,4-D/H	0.24-0.95 a.e.	May/2-4	L
	and			
	Disulfoton/I	0.75-1.0	As Needed	E or G
Dryland Wheat or Barley/1	2,4-D/H	0.24-0.95 a.e.	May/1-3	L
	or			
	Chlorsulfuron/H	0.01-0.02	May/1-4	F
	and			
	Disulfoton/I	1.0	As Needed	E or G
Fallow/2	None			
Corn/1-3	Atrazine/H	1.2-2.4	May/1-3	L
	or			
	Metolachlor/H	1.5-3.0	May/1-3	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

County: Salt Lake (2 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Corn/1-3 continued	and			
	Carbofuran/I	1.0	May/1-3	G
Small Grains/4-5	2,4-D/H	0.24-0.95 a.e.	May/2-4	L
	and			
	Disulfoton/I	0.75-1.0	As Needed	E or G
Cucumbers	Bensulide/H	5.0	May/2	E
Sweet Corn	Alachlor/H	4.0	May/2	E
	or			
	EPTC plus Safener/H	4.0	May/2	E
	and			
	Permethrin/I	0.2	July/5	E
Tomatoes	Trifluralin/H	1.0	July/1	E
Apples and Pears	Dormant Oil/I	6-9 gallons	March/1-2	L
	and			
	Diazinon/I	4.0	March/1-2	WP
	or			
	Endosulfan/I	4.0	March/1-2	WP
	and			
	Azinphos-Methyl/I	2.0	May/2 and August/2	E
	and			
	Triadimefon/F	0.25	April/1 and July/4	WP

F = Fungicide
H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
G = Granular
L = Liquid
WP = Wettable Powder

unty: San Juan (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Wheat	2,4-D/H	0.25-1.0 a.e.	Post Emergent	L
	and/or			
	Dicamba/H	0.1	Post Emergent	L
Alfalfa and/or Grass	None			
Safflower	None			

= Herbicide

a.i. = active ingredient
a.e. = acid equivalent

L = Liquid

County: Sanpete (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/2-6	Metribuzin/H	0.375-1.0	Fall or Spring	F
	and			
	Carbofuran/I	1.0	June/1	F
Small Grains/7-8	2,4-D/H	0.24-0.95 a.e.	June/2	L
Alfalfa/1	None			
Alfalfa/2-6	Metribuzin/H	0.375-1.0	Fall or Spring	F
	and			
	Carbofuran/I	1.0	June/1	F
Field Corn/7-8	Atrazine/H	1.2-2.4	May/4	L
	and			
	2,4-D/H	0.24-0.95 a.e.	June/3	L
	and			
	Dicamba/H	0.25-0.5	June/3	L
	and			
	Phorate/I	1.2 oz/1,000 row ft.	Planting	G
or				
Cabbage and Cauliflower/7-8	Bacillus thuringenesis/I	1.0-2.0 quarts	As Needed	L
	and			
	Oxydemeton-Methyl/I	0.375-0.5	As Needed	E
Small Grains/9-10	2,4-D/H	0.24-0.95 a.e.	June/2	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

County: Sevier (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/2-8	Hexazinone/H	1.0	March/1	L
	or			
	Metribuzin/H	0.75	March/1	F
	or			
	None			
	and			
	Carbofuran/I	0.5-1.0	May/3	F
	or			
	Parathion/I	0.25-0.5	May/2-3	E
	or			
	None			
Field Corn/9-15	Atrazine/H	2.0	April/4	L or WP
	and/or			
	Dicamba/H	0.5	May/2	L
	and			
	Trimethacarb/I	1.2oz/1000 row ft	May/1	G
	or			
	Fonofos/I	0.75-1.0	May/1	G
	or			
	Carbofuran/I	2.0-3.0	May/1	G
	or			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

County: Sevier (2 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Corn/9-15 continued	Phorate/I	1.2oz/1000 row ft	May/1	G
	or			
	Terbufos/I	1.2oz/1000 row ft	May/1	G
Small Grains/16	Triallate/H	1.0-1.5	April/1	E or G
	or			
	Barban/H	0.25-0.375	April/4	E
	or			
	Diclofop/H	0.75-1.25	April/4	E
	or			
	Difenzoquat/H	0.7-1.0	May/1	L
	and/or			
	2,4-D/H	0.5-0.95	May/3	L
	or None			
Carrots	Trifluralin/H	0.375	March-June	E
	and			
	Linuron/H	1.5-3.0	6 weeks after Trifluralin	E
Potatoes	None			
Apples, Apricots, Cherries, and Peaches	Azinphos-Methyl/I	1.5	June/1, July/1, August/1 3 applications	WP
	or			
	Phosmet/I	4.0-6.0	June/1&3, July/1&3, August/1&3 6 applications	WP

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
G = Granular
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	2.0 a.e.	Preplant	L
Alflafa/2-6 (About 15% treated)	Pronamide/H	1.75	November/2	WP
	or			
	Hexazinone/H	1.25	November/2	L
Barley/7-8 (About 60% treated with herbicide and 20% treated with insecticide)	2,4-D/H	0.25 a.e.	June/2	L
	and			
	Carbofuran/I	0.25	June/2	F
or				
ıts/7-8	2,4-D/H	0.25 a.e.	June/2	L

= Herbicide
. = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

F = Flowable
L = Liquid
WP = Wettable Powder

County: Tooele (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	EPTC/H	2.0-3.0	Preplant	G
Alfalfa/2-7	Paraquat/H	1.0	March/4	L
	and/or			
	Simazine/H	1.0	October/3-4	G
	and			
(Insecticide applied in only 1 year)	Malathion/I	1.25	May/3	E
	or			
	Methyl Parathion/I	0.5	May/3	E
	or			
	Carbofuran/I	0.25-1.0	May/3	F
Small Grains/8	2,4-D/H	0.5 a.e.	May/3	L
	or			
	MCPA/H	0.25-0.75 a.e.	Spring	L
	or			
	Bromoxynil + MCPA/H	0.25-0.5 a.i. and a.e.	Fall or Spring	L
Small Grains/9	None			
Field Corn/10-11	Cyanazine/H	1.25-3.0	April/4	L
	and			
	Fonofos/I	0.75-1.0	April/4	G
	or			
	Terbufos/I	1.2 oz/1,000 row ft	April/4	G

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid

ounty: Uintah (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/ 1-10	Hexazinone/H	1.0	Fall or Spring	L
	or			
	Metribuzin/H	0.75	Fall or Spring	F
	and			
(Insect- icides not used every year)	Parathion/I	0.5	June	E
	or			
	Malathion/I	1.25	June	E
	or			
	Carbofuran/I	0.5	June	F
Field Corn/11	Atrazine/H	2.25	Preplant, Preemergent or Post Emergent	L
Field Corn/12	2,4-D/H	0.25 a.e.	June/1-2	L
	and/or			
	Dicamba/H	0.25-0.5	June/1-2	L
Small Grains/13	2,4-D/H	0.24-0.95 a.e.	Post Emergent	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

County: Utah (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Glyphosate/H	2.0 a.e.	April	L
Alfalfa/2-5 (About 10% treated with herbicide)	Hexazinone/H	0.5	Fall or Spring	L
	and			
	Carbofuran/I	0.5-1.0	May/2	F
Corn/6-7	Atrazine/H	1.5	Preplant, Preemergent or Post Emergent	L or WP
	and/or			
	2,4-D/H	0.25 a.e.	June	L
	and			
	Diazinon/I	1 oz/1,000 row ft	May/1	G
Small Grains/8-9	2,4-D/H	0.5 a.e.	May	L
	and			
	Difenzoquat/H	0.75	April	L
Alfalfa/1	Glyphosate/H	2.0 a.e.	May	L
Alfalfa/2-8 (About 10% treated with herbicide)	Hexazinone/H	0.5	Fall or Spring	L
	and			
	Carbofuran/I	0.5-1.0	May/2	F
Small Grains/9-10	2,4-D/H	0.5 a.e.	May	L
	and/or			
	Dicamba/H	0.125	May	L
	and			

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Application Date	Formulation
Small Grains/9-10 continued	Difenzoquat/H	0.75	April	L
	and			
	Chlorsulfuron/H	0.016	April	F
Apples and Cherries	Azinphos-Methyl/I	1.0-2.0	June/1, June/4, July/3, August/2 4 applications	WP
	or			
	Parathion/I (Apples)	3.0-4.0	June/1, June/4, July/3, August/2 4 applications	E
	and			
	Propargite/A (Apples)	5.0	June/3, July/3, August/4 3 applications	WP
	and			
	Benomyl/F	0.5-1.5	May/1,3; June/1,3; July/1 5 applications	WP
	or			
	Triadimefon/F	0.25-0.5	May/1,3; June/1,3; July/1 5 applications	WP

A = Acaricide
I = Insecticide
F = Fungicide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

County: Wasatch (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/2-7 (About 10% treated)	Carbofuran/I	0.25-1.0	June/3	F
Small Grains/8-9	Glyphosate/H	2.0-3.0 a.e.	September/1	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

F = Flowable
L = Liquid

)unty: Washington (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	None			
Alfalfa/2-4 (About 20-25% treated with Hexazinone and less than 5% with Metribuzin)	Hexazinone/H	1.0-2.0	February/4	L
	or			
	Metribuzin/H	0.4-1.0	February/4	F
	and			
	Chlorpyrifos/I	0.25	April/1	E
	or			
	Parathion/I	0.50	April/1	E
Small Grains/5-6	None			
"ield orn or Sorghum/7	None			
Peaches	Azinphos-Methyl/I	2.0-4.0	May/3 and June/1 2 applications	WP

H = Herbicide
= Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

County: Wayne (1 of 1)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1-2	None			
Alfalfa/3	Carbofuran/I	0.5	June/4	F
	or			
	Parathion/I	0.5	July/1	E
Alfalfa/4-5	None			
Alfalfa/6	Glyphosate/H	1.0 a.e.	October/1	L
Small Grains/7-8	2,4-D/H	0.75-1.0 a.e.	June/1-3	L
or				
Field Corn/7-8	Carbofuran/I	0.5	May/5	F
	and			
	2,4-D/H	0.5-0.75 a.e	June/1	L
	and			
	Dicamba/H	0.25	June/1	L

H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid

County: Weber (1 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Alfalfa/1	Carbofuran/I	0.75	June/3	F
Alfalfa/2	None			
Alfalfa/3	Hexazinone/H	1.0	June/1	L
Alfalfa/4-6	None			
Spring Barley/7-8	2,4-D/H	0.5-0.75 a.e.	June/1	L
Alfalfa/1	Carbofuran/I	0.5-1.0	June/2	F
Alfalfa/2	Metribuzin/H	0.4-1.0	February/4	L
Alfalfa/3-6	None			
Field Corn/7	Fonofos/I	0.5	May/1	G
	and			
	Metolachlor/H	1.5-3.0	April/4	E
Wheat/8	2,4-D/H	0.5-0.75 a.e.	May/3	L
Onions/1	DCPA/H	10.0	March/4	WP
	and			
	Oxyfluorfen/H	0.25	May/2	E
	and			
	Methyl Parathion/I	0.5	July/2	F
	and			
	Mevinphos/I	0.5	July/4	L
Fall Barley/2	2,4-D/H	0.5-0.75 a.e.	June/1	L

= Herbicide
= Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
G = Granular
L = Liquid
WP = Wettable Powder

County: Weber (2 of 2)

Crop/Year	Pesticide/Type	Lbs a.i. or a.e./Acre	Applied Mnth/Wk	Formulation
Snap Beans/3	Trifluralin/H	0.75	May/2	E
	or			
	EPTC/H	3.0	May/2	E
	and			
	Bentazon/H	0.75	June/3	L
	and			
	Malathion/I	1.50	July/1	E
Apricots and Peaches	Dormant Oil/I	7 gal/acre	March/2	L
	and			
	Endosulfan/I	1.0	March/2	WP
	and			
	Chlorpyrifos/I	0.5	June/4	E
	and			
	Chlorothalonil/F	2.5	October/3	F
Apples and Pears	Dormant Oil/I	6 gal/acre	March/3	L
	and			
	Methidathion/I	1.0	March/3	E
	and			
	Azinphos-Methyl/I	2.0	June/3 - August/2 4 applications	WP
	and			
	Benomyl/F	0.5	June/4 and July/2 2 applications	WP

F = Fungicide
H = Herbicide
I = Insecticide

a.i. = active ingredient
a.e. = acid equivalent

E = Emulsifiable Concentrate
F = Flowable
L = Liquid
WP = Wettable Powder

APPENDIX C

Library of Pesticides Used in Utah

Library of Pesticide Used in Utah

Pesticide Library		Use[1]	Health Advisory(ppb)
Common Name	:2,4-D ACID	H	70
Partition Coefficient	:20 mg/g OC		
Half-Life	:10 days		
Trade Name	:DACAMINE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-D ESTER	H	70
Partition Coefficient	:1000 mg/g OC		
Half-Life	:10 days		
Trade Name	:AQUA KLEEN		
Trade Name	:WEEDONE		
Trade Name	:EMULSAMINE		
Trade Name	:.		
Common Name	:2,4-D AMINE SALT	H	70
Partition Coefficient	:109 mg/g OC		
Half-Life	:10 days		
Trade Name	:WEEDAR		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-DB AMINE SALT	H	70
Partition Coefficient	:20 mg/g OC		
Half-Life	:10 days		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-DB ESTER	H	70
Partition Coefficient	:1000 mg/g OC		
Half-Life	:10 days		
Trade Name	:BUTYRAC ESTER		
Trade Name	:BUTOXONE		
Trade Name	:.		
Trade Name	:.		

[1] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:ALACHLOR	H	1.5
Partition Coefficient	:190 mg/g OC		
Half-Life	:14 days		
Trade Name	:LASSO		
Trade Name	:PILLARZO		
Trade Name	:ALANEX		
Trade Name	:.		
Common Name	:ALDICARB	I	10
Partition Coefficient	:30 mg/g OC		
Half-Life	:30 days		
Trade Name	:TEMIK		
Trade Name	:TEMIK15G		
Trade Name	:OMS 771		
Trade Name	:UC21149		
Common Name	:ATRAZINE	H	3
Partition Coefficient	:160 mg/g OC		
Half-Life	:60 days		
Trade Name	:AATREX		
Trade Name	:GRIFFEX		
Trade Name	:ATRANEX		
Trade Name	:VECTAL SC		
Common Name	:AZINPHOS-METHYL	I	
Partition Coefficient	:1000 mg/g OC		
Half-Life	:40 days		
Trade Name	:GUTHION		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:BARBAN	I	
Partition Coefficient	:30 mg/g OC		
Half-Life	:30 days		
Trade Name	:CARBYNE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:BENOMYL	F	
Partition Coefficient	:2100 mg/g OC		
Half-Life	:100 days		
Trade Name	:BENLATE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:BENSULIDE	H	
Partition Coefficient	:10000 mg/g OC		
Half-Life	:60 days		
Trade Name	:PREFAR		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:BENTAZONE	H	
Partition Coefficient	:35 mg/g OC		
Half-Life	:10 days		
Trade Name	:BASAGRAN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:BROMOCIL	H	
Partition Coefficient	:72 mg/g OC		
Half-Life	:106 days		
Trade Name	:HYVAR XL		
Trade Name	:BOROCIL		
Trade Name	:UREABOR		
Trade Name	:HYVAR X		
Common Name	:BROMOXYNIL	H	
Partition Coefficient	:1000 mg/g OC		
Half-Life	:14 days		
Trade Name	:BROMINAL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:CARBARYL	I	700
Partition Coefficient	:229 mg/g OC		
Half-Life	:7 days		
Trade Name	:SEVIN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:CARBOFURAN	I	36
Partition Coefficient	:29 mg/g OC		
Half-Life	:37 days		
Trade Name	:FURADAN		
Trade Name	:BAY 70143		
Trade Name	:YALTOX		
Trade Name	:CURATERR		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:CHLOROTHALONIL	F	1.5
Partition Coefficient	:1380 mg/g OC		
Half-Life	:20 days		
Trade Name	:BRAVO		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:CHLORPYRIFOS	I	
Partition Coefficient	:6070 mg/g OC		
Half-Life	:63 days		
Trade Name	:LORSBAN		
Trade Name	:DURSBAN		
Trade Name	:BRODAN		
Trade Name	:ERADEX		
Common Name	:CHLORSULFURON	H	
Partition Coefficient	:1 mg/g OC		
Half-Life	:30 days		
Trade Name	:GLEAN		
Trade Name	:TELAR		
Trade Name	:.		
Trade Name	:.		
Common Name	:CYANAZINE	H	9
Partition Coefficient	:168 mg/g OC		
Half-Life	:20 days		
Trade Name	:BLADEX		
Trade Name	:FORTROL		
Trade Name	:SD 15418		
Trade Name	:WL 19805		
Common Name	:DAMINOZIDE	G	
Partition Coefficient	:10 mg/g OC		
Half-Life	:7 days		
Trade Name	:ALAR		
Trade Name	:B-NINE		
Trade Name	:KYLAR		
Trade Name	:.		
Common Name	:DCPA	H	3500
Partition Coefficient	:5000 mg/g OC		
Half-Life	:100 days		
Trade Name	:DACTHAL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:DEMENTON	I	35
Partition Coefficient	:51 mg/g OC		
Half-Life	:30 days		
Trade Name	:METASYSTOX		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:DIAZINON	I	.63
Partition Coefficient	:85 mg/g OC		
Half-Life	:30 days		
Trade Name	:SPECTRACIDE		
Trade Name	:DIANON		
Trade Name	:BASUDIN		
Trade Name	:.		
Common Name	:DICAMBA	H	9
Partition Coefficient	:2 mg/g OC		
Half-Life	:14 days		
Trade Name	:BANVEL D		
Trade Name	:BANEX		
Trade Name	:DIANAT		
Trade Name	:WEEDMASTER		
Common Name	:DICLOFOP	H	
Partition Coefficient	:48500 mg/g OC		
Half-Life	:10 days		
Trade Name	:HOELON		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:DIFENZOQUAT	H	
Partition Coefficient	:100000 mg/g OC		
Half-Life	:90 days		
Trade Name	:AVENGE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:DIMETHOATE	I	
Partition Coefficient	:8 mg/g OC		
Half-Life	:7 days		
Trade Name	:CYGON		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:DISULFOTON	I	.3
Partition Coefficient	:1603 mg/g OC		
Half-Life	:5 days		
Trade Name	:DISYSTON		
Trade Name	:DITHIOSYSTOX		
Trade Name	:THIODEMETON		
Trade Name	:DITHIODEMETON		
Common Name	:DIURON	H	
Partition Coefficient	:383 mg/g OC		
Half-Life	:328 days		
Trade Name	:KARMEX		
Trade Name	:UROX D		
Trade Name	:DIREX 4L		
Trade Name	:DIUROL		
Common Name	:ENDOSULFAN	I	
Partition Coefficient	:200000 mg/g OC		
Half-Life	:43 days		
Trade Name	:THIODAN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:EPTC	H	
Partition Coefficient	:280 mg/g OC		
Half-Life	:30 days		
Trade Name	:EPTAM		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:FENVALERATE	I	
Partition Coefficient	:100000 mg/g OC		
Half-Life	:50 days		
Trade Name	:PYDRIN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:FLUAZIFOP-P-BUTYL	H	
Partition Coefficient	:3000 mg/g OC		
Half-Life	:20 days		
Trade Name	:FUSILADE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:FONOFOS	I	14
Partition Coefficient	:680 mg/g OC		
Half-Life	:60 days		
Trade Name	:DYFONATE		
Trade Name	:N-2790		
Trade Name	:.		
Trade Name	:.		
Common Name	:GLYPHOSATE	700	
Partition Coefficient	:10000 mg/g OC		
Half-Life	:30 days		
Trade Name	:ROUNDUP		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:HEXAZINONE	H	210
Partition Coefficient	:11 mg/g OC		
Half-Life	:60 days		
Trade Name	:VELPAR		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:MALATHION	I	140
Partition Coefficient	:1797 mg/g OC		
Half-Life	:1 days		
Trade Name	:CYTHION		
Trade Name	:CALMATHION		
Trade Name	:CARBOFOS		
Trade Name	:MERCAPTOTHION		
Common Name	:MANEB	F	
Partition Coefficient	:1000 mg/g OC		
Half-Life	:12 days		
Trade Name	:DITHANE		
Trade Name	:MANEB		
Trade Name	:.		
Trade Name	:.		
Common Name	:MCPA	H	3.6
Partition Coefficient	:1000 mg/g OC		
Half-Life	:30 days		
Trade Name	:WEEDONE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:METHIDATHION	I	
Partition Coefficient	:780 mg/g OC		
Half-Life	:21 days		
Trade Name	:SUPRACIDE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:METHYL PARATHION	I	2
Partition Coefficient	:5102 mg/g OC		
Half-Life	:5 days		
Trade Name	:METAFOS		
Trade Name	:PARATHION-METHYL		
Trade Name	:DEVITHION		
Trade Name	:NITROX 80		
Common Name	:METOLACHLOR		
Partition Coefficient	:200 mg/g OC	H	10
Half-Life	:20 days		
Trade Name	:DUAL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:METRIBUZIN	H	175
Partition Coefficient	:41 mg/g OC		
Half-Life	:30 days		
Trade Name	:LEXONE		
Trade Name	:SENCOR		
Trade Name	:.		
Trade Name	:.		
Common Name	:METSULFURON	H	
Partition Coefficient	:61 mg/g OC		
Half-Life	:120 days		
Trade Name	:ALLY		
Trade Name	:ESCORT		
Trade Name	:.		
Trade Name	:.		
Common Name	:MEVINPHOS	I	
Partition Coefficient	:1 mg/g OC		
Half-Life	:3 days		
Trade Name	:PHOSDRIN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:NAPTALAM	H	
Partition Coefficient	:30 mg/g OC		
Half-Life	:7 days		
Trade Name	:ALANAP		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:OXYDEMETON-METHYL	I	
Partition Coefficient	:1 mg/g OC		
Half-Life	:20 days		
Trade Name	:MSR		
Trade Name	:METASYSTOX		
Trade Name	:.		
Trade Name	:.		
Common Name	:OXYFLUORFEN	H	
Partition Coefficient	:100000 mg/g OC		
Half-Life	:30 days		
Trade Name	:GOAL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PARAQUAT	H	
Partition Coefficient	:100000 mg/g OC		
Half-Life	:3600 days		
Trade Name	:GRAMOXONE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PARATHION	H	35
Partition Coefficient	:1000 mg/g OC		
Half-Life	:14 days		
Trade Name	:THIOPHOS		
Trade Name	:BLADAN		
Trade Name	:ORTHOPHOS		
Trade Name	:PANTHION		
Common Name	:PERMETHRIN	I	
Partition Coefficient	:10600 mg/g OC		
Half-Life	:30 days		
Trade Name	:POUNCE		
Trade Name	:AMBUSH		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:PHORATE	I	
Partition Coefficient	:1000 mg/g OC		
Half-Life	:90 days		
Trade Name	:THIMET		
Trade Name	:RAMPART		
Trade Name	:AGRIMET		
Trade Name	:GEOMET		
Common Name	:PHOSMET	I	
Partition Coefficient	:740 mg/g OC		
Half-Life	:20 days		
Trade Name	:IMIDAN		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PROMETON	H	100
Partition Coefficient	:300 mg/g OC		
Half-Life	:120 days		
Trade Name	:PRAMITOL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PRONAMIDE	H	52
Partition Coefficient	:990 mg/g OC		
Half-Life	:30 days		
Trade Name	:KERB		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PROPARGITE	M	
Partition Coefficient	:8000 mg/g OC		
Half-Life	:20 days		
Trade Name	:COMITE		
Trade Name	:OMITE		
Trade Name	:.		
Trade Name	:.		
Common Name	:SETHOXYDIM	H	
Partition Coefficient	:50 mg/g OC		
Half-Life	:5 days		
Trade Name	:POAST		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

Pesticide Library Cont.		Use	Health Advisory(ppb)
Common Name	:SIMAZINE	H	35
Partition Coefficient	:138 mg/g OC		
Half-Life	:75 days		
Trade Name	:AQUAZINE		
Trade Name	:PRINCEP		
Trade Name	:SIMADEX		
Trade Name	:SIM-TROL		
Common Name	:TERBUFOS	I	.18
Partition Coefficient	:3000 mg/g OC		
Half-Life	:5 days		
Trade Name	:COUNTER		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:TRIALLATE	H	
Partition Coefficient	:3600 mg/g OC		
Half-Life	:60 days		
Trade Name	:FARGO		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:TRIADIMEFON	F	
Partition Coefficient	:273 mg/g OC		
Half-Life	:21 days		
Trade Name	:BAYLETON		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:TRIFLURALIN	H	2
Partition Coefficient	:1400 mg/g OC		
Half-Life	:70 days		
Trade Name	:TREFLAN		
Trade Name	:TREFANOCIDE		
Trade Name	:ELANCOLAN		
Trade Name	:TRIM		
Common Name	:TRIMETHACARB	I	
Partition Coefficient	:200 mg/g OC		
Half-Life	:10 days		
Trade Name	:BROOT		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		

APPENDIX D

Soil Library Used in Utah

Soil Library Used in Utah

Soil Name : ABRAHAM Identifier : UT0132

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.20	0.10	1.45	25.0	13.0	43.0
2	0.84	0.20	1.45	25.0	13.0	43.0
3	1.35	0.10	1.45	25.0	13.0	43.0
4	1.60	0.10	1.45	25.0	13.0	43.0

Soil Name : DUCHESNE Identifier : DU1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	5.00	1.45	17.0	8.0	40.0
2	0.30	1.00	1.50	17.0	8.0	40.0
3	0.40	0.50	1.50	17.0	8.0	40.0
4	0.50	0.20	1.50	17.0	8.0	40.0
5	0.60	0.10	1.50	17.0	8.0	40.0

Soil Name : GENOLA Identifier : UT1475

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.18	0.80	1.35	19.0	10.5	43.0
2	0.33	1.86	1.35	19.4	11.3	43.0
3	0.48	0.35	1.35	20.8	7.4	43.0
4	0.58	0.29	1.35	22.7	7.6	43.0
5	0.79	0.23	1.40	19.5	13.1	43.0
6	0.86	0.23	1.35	21.9	9.0	43.0
7	0.94	0.30	1.40	15.2	10.3	43.0
8	1.02	0.17	1.40	17.4	5.0	43.0
9	1.07	0.23	1.35	19.5	11.3	43.0
10	1.17	0.10	1.35	19.5	11.3	43.0

Soil Name : GRAND Identifier : GRN1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.20	1.45	22.0	8.0	40.0
2	0.30	1.00	1.45	22.0	8.0	40.0
3	0.40	0.50	1.45	22.0	8.0	40.0
4	0.50	0.20	1.45	22.0	8.0	40.0
5	0.60	0.10	1.45	22.0	8.0	40.0

Soil Name : HARRISBURG Identifier : UTU003

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.05	0.22	1.70	13.0	5.5	40.0
2	0.41	0.14	1.66	13.5	6.0	40.0
3	0.66	0.09	1.69	13.5	6.0	40.0
4	0.89	0.21	1.59	13.5	6.5	40.0
5	0.99	0.10	1.59	13.5	6.5	40.0

Soil Name : HILLFIELD Identifier : UT0394

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.08	2.48	1.44	23.0	11.0	41.2
2	0.25	1.77	1.44	23.0	11.0	41.2
3	0.46	1.03	1.45	22.0	10.0	41.2
4	0.79	0.65	1.35	25.0	12.0	41.2
5	1.27	0.20	1.45	18.0	8.0	41.2
6	1.63	0.10	1.45	18.0	8.0	41.2

Soil Name : JUAB Identifier : UT0699

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.10	1.69	1.40	24.0	8.1	43.0
2	0.20	0.81	1.40	26.0	10.0	43.0
3	0.33	0.89	1.40	27.0	9.9	43.0
4	0.53	0.36	1.40	25.0	8.6	43.0
5	0.74	0.49	1.50	23.0	7.8	43.0
6	0.97	0.34	1.45	24.0	8.0	43.0
7	1.52	0.30	1.26	30.0	12.0	43.0
8	1.62	0.10	1.26	30.0	12.0	43.0

Soil Name : KANE Identifier : KA1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.50	18.0	8.0	40.0
2	0.30	0.50	1.50	18.0	8.0	40.0
3	0.60	0.30	1.50	18.0	8.0	40.0
4	0.90	0.20	1.50	18.0	8.0	40.0
5	1.00	0.10	1.50	18.0	8.0	40.0

Soil Name : IRON Identifier : IR1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.10	1.69	1.40	24.0	8.1	43.0
2	0.20	0.81	1.40	26.0	10.0	43.0
3	0.33	0.89	1.40	27.0	9.9	43.0
4	0.53	0.36	1.40	25.0	8.6	43.0
5	0.74	0.49	1.50	23.0	7.8	43.0
6	0.97	0.34	1.45	24.0	8.0	43.0
7	1.52	0.30	1.26	30.0	12.0	43.0
8	1.62	0.10	1.26	30.0	12.0	43.0

Soil Name : KIDMAN Identifier : UT0395

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.28	1.20	1.52	18.0	6.4	40.0
2	0.43	0.70	1.52	18.5	6.4	40.0
3	0.53	0.80	1.53	20.0	6.9	40.0
4	0.69	0.40	1.54	22.0	7.0	40.0
5	0.94	0.20	1.40	21.5	5.3	40.0
6	1.24	0.20	1.45	21.5	5.7	40.0
7	1.47	0.10	1.42	18.0	4.4	40.0

Soil Name : KOVICH Identifier : UT0306

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.03	11.00	1.50	25.0	13.0	43.0
2	0.28	2.60	1.50	23.0	13.0	43.0
3	0.61	1.30	1.50	26.0	15.0	43.0
4	0.74	0.60	1.55	23.0	14.0	43.0
5	1.04	0.70	1.60	22.0	13.0	43.0
6	1.14	0.10	1.60	22.0	13.0	43.0

Soil Name : LASIL Identifier : UT0583

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	2.10	1.42	33.0	13.0	50.0
2	0.23	1.50	1.44	33.0	14.3	50.0
3	0.33	0.80	1.44	36.0	14.7	50.0
4	0.48	0.50	1.40	38.0	20.4	50.0
5	0.58	0.50	1.42	37.0	18.0	50.0
6	0.91	0.40	1.42	40.0	18.0	50.0
7	1.12	0.40	1.43	37.0	16.5	50.0
8	1.52	0.40	1.45	38.0	16.8	50.0

Soil Name : LAYTON　　Identifier : UT0338

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.18	0.70	1.55	12.5	3.7	40.0
2	0.38	0.50	1.55	13.0	4.0	40.0
3	0.58	0.20	1.55	14.0	4.5	40.0
4	0.74	0.20	1.55	12.5	4.0	40.0
5	1.04	0.10	1.54	12.0	3.3	40.0
6	1.68	0.10	1.52	8.0	1.7	42.0

Soil Name : LEWISTON　　Identifier : UT0546

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.25	0.60	1.55	14.0	7.0	41.0
2	0.33	0.42	1.66	16.0	11.0	41.0
3	0.56	0.39	1.59	22.0	14.0	41.0
4	0.81	0.16	1.64	18.0	12.0	41.0
5	1.52	0.08	1.58	12.0	6.0	41.0

Soil Name : MANDERFIELD　　Identifier : UTU001

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.13	1.62	1.45	22.6	16.3	43.0
2	0.41	0.64	1.40	20.5	11.1	43.0
3	0.61	0.60	1.45	20.8	10.1	43.0
4	0.84	0.29	1.45	22.0	10.0	43.0
5	1.17	0.26	1.45	19.0	10.0	43.0
6	1.52	0.20	1.45	18.7	5.5	43.0
7	1.62	0.10	1.45	18.7	5.5	43.0

Soil Name : MARTINI　　Identifier : UT0404

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.13	1.80	1.28	18.0	9.0	40.0
2	0.38	0.60	1.46	14.5	8.0	40.5
3	0.48	0.10	1.55	9.0	4.5	40.0
4	1.14	0.60	1.44	17.0	9.0	40.0
5	1.78	0.50	1.52	14.0	8.0	40.0
6	1.88	0.10	1.52	14.0	8.0	40.0

Soil Name : MONTICELLO — Identifier : UT0454

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.08	1.33	1.52	22.0	13.0	41.0
2	0.20	0.81	1.52	20.0	12.0	41.0
3	0.56	0.41	1.50	25.0	14.0	41.0
4	0.81	0.27	1.45	27.0	16.0	43.0
5	1.14	0.16	1.43	27.0	15.0	43.0
6	1.42	0.16	1.50	25.0	14.0	43.0
7	1.52	0.10	1.50	25.0	14.0	43.0

Soil Name : PENOYER — Identifier : UTU002

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.10	1.00	1.45	24.0	13.0	43.0
2	0.23	1.20	1.40	25.0	13.0	43.0
3	0.58	0.60	1.52	19.0	10.0	43.0
4	1.04	0.18	1.46	23.0	11.0	43.0
5	1.52	0.06	1.40	22.0	11.0	43.0

Soil Name : PHAGE — Identifier : PI1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.05	1.08	1.50	15.0	8.0	40.0
2	0.23	1.42	1.50	18.0	10.0	40.0
3	1.02	0.91	1.50	27.0	12.0	40.0
4	1.42	0.10	1.50	19.0	8.0	40.0

Soil Name : RAVOLA — Identifier : UT0480

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.20	1.00	1.45	25.0	13.0	43.0
2	1.52	0.50	1.45	25.0	15.0	43.0
3	1.62	0.10	1.45	25.0	15.0	43.0

Soil Name : SALERATUS — Identifier : UT0709

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.40	25.0	15.0	45.0
2	1.14	0.50	1.30	35.0	20.0	45.0
3	1.52	0.20	1.30	30.0	15.0	45.0
4	1.62	0.10	1.30	30.0	15.0	45.0

Soil Name : SEVIER Identifier : SE1

Horizon	Depth	Organic Carbon	Bulk Density	Volumetric Water Content, (%) at		
	(m)	(%)	(Mg/cu meter)	-0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.35	20.0	10.0	43.0
2	0.30	0.70	1.35	20.0	10.0	43.0
3	0.60	0.30	1.35	20.0	8.0	43.0
4	0.90	0.20	1.35	20.0	10.0	43.0
5	1.00	0.10	1.35	20.0	10.0	43.0

Soil Name : SUMMIT Identifier : UTE1229

Horizon	Depth	Organic Carbon	Bulk Density	Volumetric Water Content, (%) at		
	(m)	(%)	(Mg/cu meter)	-0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.40	25.0	12.0	43.0
2	0.30	0.70	1.40	25.0	12.0	43.0
3	0.60	0.30	1.40	25.0	12.0	43.0
4	0.90	0.20	1.40	25.0	12.0	43.0
5	1.00	0.10	1.40	25.0	12.0	43.0

Soil Name : SUNSET Identifier : UT0076

Horizon	Depth	Organic Carbon	Bulk Density	Volumetric Water Content, (%) at		
	(m)	(%)	(Mg/cu meter)	-0.01 MPa	-1.5 MPa	Saturation
1	0.43	1.20	1.40	27.0	14.0	43.0
2	1.14	0.70	1.30	23.0	10.0	49.0
3	1.60	0.10	1.55	10.0	5.0	40.0

Soil Name : TEBBS Identifier : UTE1041

Horizon	Depth	Organic Carbon	Bulk Density	Volumetric Water Content, (%) at		
	(m)	(%)	(Mg/cu meter)	-0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.40	25.0	12.0	43.0
2	0.30	0.70	1.40	25.0	12.0	43.0
3	0.60	0.30	1.40	25.0	12.0	43.0
4	0.90	0.20	1.40	25.0	12.0	43.0
5	1.00	0.10	1.40	25.0	12.0	43.0

Soil Name : THATCHER Identifier : UT0752

Horizon	Depth	Organic Carbon	Bulk Density	Volumetric Water Content, (%) at		
	(m)	(%)	(Mg/cu meter)	-0.01 MPa	-1.5 MPa	Saturation
1	0.33	1.50	1.25	30.0	15.0	49.0
2	0.79	0.70	1.35	35.0	21.0	41.0
3	1.52	0.20	1.45	22.0	12.0	43.0
4	1.62	0.10	1.45	22.0	12.0	43.0

Soil Name : TOOELE — Identifier : T001

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.33	1.50	1.25	30.0	15.0	49.0
2	0.79	0.70	1.35	35.0	21.0	41.0
3	1.52	0.20	1.45	22.0	12.0	43.0
4	1.62	0.10	1.45	22.0	12.0	43.0

Soil Name : VINEYARD — Identifier : UT0350

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.18	0.81	1.70	16.0	8.0	40.0
2	0.33	0.47	1.70	16.0	8.0	40.0
3	0.61	0.31	1.70	17.0	9.0	40.0
4	0.89	0.21	1.70	18.0	9.0	40.0
5	1.07	0.21	1.70	19.0	10.0	40.0
6	1.52	0.12	1.70	16.0	8.0	40.0

Soil Name : UINTA — Identifier : UI1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.08	5.00	1.35	28.0	15.0	43.0
2	0.28	1.00	1.55	15.0	8.0	40.0
3	1.07	0.30	1.63	25.0	17.0	35.0
4	1.17	0.10	1.63	25.0	17.0	35.0

Soil Name : WARMSPRINGS — Identifier : UT0415

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.20	0.80	1.62	17.0	10.0	40.0
2	0.38	0.30	1.62	19.0	12.0	40.0
3	0.61	0.10	1.64	18.0	13.0	40.0
4	0.94	0.10	1.68	16.0	10.0	40.0
5	1.52	0.10	1.65	13.0	7.0	40.0

Soil Name : WAYNE — Identifier : WA1

Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at -0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.00	1.35	20.0	10.0	43.0
2	0.30	0.70	1.35	20.0	10.0	43.0
3	0.60	0.30	1.35	20.0	8.0	43.0
5	1.00	0.10	1.35	20.0	10.0	43.0

APPENDIX E

Letters and Survey Form

MEMORANDUM

TO: County Agricultural Agents

FROM: Howard Deer

DATE: December 7, 1988

SUBJECT: Pesticide Hazards to Ground Water Quality in Utah

At our Annual Extension Conference considerable emphasis was placed on the need for a Water Quality Initiative for Utah. As a part of that effort a research project was initiated to analyze the hazards that agricultural chemicals pose to Utah's ground water. The initial phase of this research is to determine those locations in Utah that are at greatest risk of ground water contamination by pesticides. This will be accomplished by interfacing data on pesticide usage with soil and hydrologic factors. This process will identify specific areas in the state where hazards exist and will be followed by ground water sampling and analysis for pesticides.

In order to accurately identify these locations we need to have county specific information on cropping and pesticide usage. The completion of the enclosed survey form and map will make this possible. Use separate survey forms for each crop, but combine all cropping locations onto the one map. If the maps you receive from us don't cover all of your county's crop areas, please contact us right away so that we can send you additional maps. If you don't have some of the information requested please give us your best estimate. Be sure to keep a copy of your completed survey forms.

Please give it your best try at your earliest convenience. Please feel free to call if you have questions about this request. Your time and efforts are appreciated greatly. Thank you.

cc: R. Peralta
G. Olson

SURVEY ON AGRICULTURAL PRACTICES IN UTAH

DEPARTMENT OF AGRICULTURAL AND IRRIGATION ENGINEERING,
UTAH STATE UNIVERSITY, LOGAN, UTAH
OCTOBER 1988

INFORMATION GUIDING THE COMPLETION OF THE QUESTIONNAIRE

1. **Description of Crop Rotation** and **Year in Crop Rotation**

At a given location (field), crops may change as frequently as once every 40 days (vegetables), or once every 15 to 20 years (fruit trees). The survey respondent is expected to describe typical crop rotations encountered in his county. For a given field, he should describe which crop follows which one; for example, "Corn / Wheat / Sorghum" might be the crop rotation at a certain location.

Each page of the questionnaire is dedicated to only one crop. Using the above example, the first page of the questionnaire would be filled with information concerning corn and in "**Year in Crop Rotation**", "**First**" would be circled. Then, a second questionnaire page would be used to provide information concerning wheat and "**Second**" would be circled in "**Year in Crop Rotation**". Then, a third page would be used to describe agricultural practices related to Sorghum, and "**Third**" would be circled in "**Year in Crop Rotation**".

In the here described crop rotation, on a given field, crops change annually. However, it may well be that double cropping per year may take place. Then, the first crop would be described on the first page of the questionnaire, and the second crop would be described on the second page.

On both pages **"First"** would be circled as **"Year in Crop Rotation"**.

In order to keep questionnaire pages in chronological order, the investigators suggest to staple all questionnaire pages applying to a certain crop rotation together.

2. Pesticide Applied

One page of the questionnaire allows the indication of four pesticide applications per crop. An additional page may be used, if more than four pesticide applications per crop occur. The survey respondent may then indicate in "Crop Name" the continuation of the previous page.

3. Formulation

The formulation may be "Granulate", "spray", a.s.o.

4. Soil Management

The investigators are interested in receiving information on tillage and soil conservation practices.

5. Fertilizer Applied

One page of the questionnaire allows the indication of four fertilizer applications per crop. An additional page may be used, if more than four fertilizer applications per crop occur. The survey respondent may then indicate in "Crop Name" the continuation of the previous page.

SURVEY ON AGRICULTURAL PRACTICES IN UTAH

County: ....   Date(M/D/Y): ...../...../.....

Name of Survey Respondent: ....

Description of Crop Rotation [1]: ....

Crop Indicated on this Sheet: ....

Typical Soil Type: ....

Crop Development Stage	Pesticides Applied	Remarks	Irrigation
Approximate Date (week/ month) of:	Name:		Field Application Method(Sprinkler, Trickle, Furrow, Border, Basin,Center Pivot, Flood):
	Formulation:		
Planting : ...../.....	Date (week/month): ...../.....		
Emergence: ...../.....	Rate (lbs. A.I. /acre):	And / Or	....
Maturity : ...../.....	Name:		Application Depth of Water per Irrigation (in inches):
Harvest : ...../.....	Formulation:		
	Date (week/month): ...../.....		....
	Rate (lbs. A.I. /acre):	And / Or	Number of Irrigations Applied to this Crop:
	Name:		
	Formulation:		....
	Date (week/month): ...../.....		Duration of one Irrigation (hours/acre):
	Rate (lbs. A.I. /acre):	And / Or	....
	Name:		
	Formulation:		Approximate Date of First Irrigation for this Crop (W/M):
	Date (week/month): ...../.....		....
	Rate (lbs. A.I./acre):	And / Or	

(1) Indicate in parentheses the number of years this crop is grown [e.g. Alfalfa (7), Corn (2), Small Grains (1)].

Department of Agricultural & Irrigation Engineering, and the Cooperative Extension Service, Utah State University Logan, Utah.

APPENDIX F

Irrigation Schedules for Crops and Sub-regions

IRRIGATION OF ALFALFA

Planting Season

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
09/01	150	180	195	195	160	
09/10	100	125	130	130	120	
09/20	100	125	130	130	120	
10/01	100	125	130	130	120	

Following Season

05/15	75	80	85	85	90	145
06/01	150	180	195	195	160	215
06/15	150	180	195	195	160	215
07/01	150	180	195	195	160	215
07/15	150	180	195	195	160	215
08/01	150	180	195	195	160	215
08/15	150	180	195	195	160	215
09/01	150	160	165	165	165	215
09\15	75	80	80	80	90	150
TOTAL	1200	1400	1500	1500	1300	2000

IRRIGATION OF CORN

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
05/10	75	80	90	90	90	100
05/20	75	80	90	90	90	100
06/01	125	130	140	140	90	150
06/15	125	130	140	140	90	150
07/01	125	130	140	140	120	150
07/15	125	130	140	140	120	150
08/01	125	130	140	140	120	150
08/15	125	130	140	140	120	150
09/01	125	130	140	140	120	150
09/01	125	130	140	140	90	150
TOTAL	1150	1200	1300	1300	1050	1140

IRRIGATION OF WINTER WHEAT

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
05/25	150	225	250	250	175	200
06/05	150	225	250	250	175	250
06/15	190	225	250	250	175	250
07/01	150	225	250	250	175	250
07/15	150	225	250	250	175	250
TOTAL	640	900	1000	1000	700	1200

IRRIGATION OF VEGETABLES

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
05/10	50	60	67	74	50	100
05/15	50	60	67	74	50	100
05/20	50	60	67	74	50	100
05/25	50	60	67	74	50	100
05/30	80	96	104	112	80	120
06/04	80	96	104	112	80	120
06/09	80	96	104	112	80	120
06/14	80	96	104	112	80	120
06/19	80	96	104	112	80	120
06/24	80	96	104	112	80	120
06/29	80	96	106	112	80	120
07/04	80	96	104	112	80	120
07/09	80	96	103	110	80	120
07/14	80	96	103	110	80	120
TOTAL	1000	1200	1300	1400	1000	1600

IRRIGATION OF ONIONS

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
05/01	50	60	60	65	65	75
05/10	50	60	60	65	65	75
05/20	50	60	60	70	70	90
06/01	75	90	90	100	100	120
06/10	75	90	90	100	100	120
06/20	75	90	90	100	100	120
07/01	75	90	90	100	100	120
07/10	75	90	90	100	100	120
07/20	75	90	90	100	100	120
08/01	75	90	90	100	100	120
08/10	75	90	90	100	100	120
TOTAL	750	900	900	1000	1000	1200

IRRIGATION OF ORCHARDS

Date	N. Central	S. Central	Uintah Basin	South W.	South E.	Dixie
05/01	75	90	90	90	75	90
05/15	100	120	120	125	100	120
06/01	125	150	150	155	125	150
06/15	125	150	150	160	125	150
07/01	125	150	150	160	125	150
07/15	125	150	150	160	125	150
08/01	125	150	150	160	125	150
08/15	125	150	150	160	125	150
09/01	125	150	150	160	125	150
09/15	125	150	150	160	125	150
10/01	125	150	150	160	125	150
10/15	100	100	150	160	125	150
TOTAL	1400	1600	1600	1700	1400	1600