ANNUAL REPORT
FOR 2003

STATUS OF IMPLEMENTATION
OF SENATE BILL 90-126
THE AGRICULTURAL CHEMICALS AND
GROUNDWATER PROTECTION ACT

Colorado Department of Agriculture
Colorado State University Cooperative Extension
Colorado Department of Public Health and Environment

www.ag.state.co.us/DPI/GroundWater/home.html

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Executive Summary

Status of Implementation of Senate Bill 90-126
The Agricultural Chemicals and Groundwater Protection Act

In the annual report for 2002, several goals for 2003 were identified by the cooperating agencies. The progress made toward each of the goals is detailed in the following pages.

Memoranda of Understanding

Memoranda of Understanding as provided in Section 25-8-205.5 (3) (f) and (g) of the Act have been signed for fiscal year 2004 between the Colorado Department of Agriculture and: 1) Colorado State University Cooperative Extension, and 2) the Colorado Department of Public Health and Environment. The program objectives for 2004 are stated on pages five through seven.

Colorado Department of Agriculture

Storage Regulations

Section 25-8-205.5 (3)(b) of the Agricultural Chemicals and Groundwater Protection Act requires the Commissioner of Agriculture to develop regulations where pesticides and fertilizers are stored or handled in quantities that exceed the established thresholds. Pesticide and fertilizer facility inspections continued in 2003.

Pesticide Management Plan

EPA is developing a program that would require states to produce management plans for pesticides thought to be significant hazards to groundwater. If a state wants to allow continued use of any of the pesticides identified, it must produce an EPA-approved management plan specific to that pesticide. EPA concurred on Colorado's Generic Pesticide Management Plan (PMP) in March of 2000. This generic plan will be used as a model to produce the pesticide specific plans.

Waste Pesticide Disposal

MSE Environmental Inc., the private contractor, conducted another "Chemsweep" program in 2003.

Advisory Committee

The advisory committee continues to be an integral part of the implementation of this program by providing input from the many facets of the agricultural community and the general public that they represent (Appendix V). The committee met once during 2003.

Legislation

The program personnel have proposed legislation regarding changing the program's fee structure. Due to the effects of both drought and the economy, program revenues have declined over the last several years. This has necessitated cuts in both personnel and operating expenses that are adversely affecting the way the program is operated. After 13 years at the current funding levels, a fee increase is necessary in order to effectively implement this program. The proposed legislation was not introduced to the General Assembly during the 2004 legislative session.

Groundwater Monitoring

In 2003, the program completed the ninth year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. From June through August 2003, 62 wells in the long-term network were sampled. Nitrogen analysis indicated that 68% of the monitoring wells and 69% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. Pesticide results for the monitoring well portion of the network revealed six pesticides, Atrazine, 2,4-D, Hexazinone, Metolachlor, Picloram, and Simazine present in the Weld County monitoring well samples. The breakdown product of Atrazine, Deethyl Atrazine, was also detected. Atrazine was present in 32% and Deethyl Atrazine in 47% of the wells. Metolachlor was detected in 32% of the wells, Hexazinone, Picloram, Simazine, and 2,4-D were each detected in one well. Detection levels ranged from 0.09 for Picloram to 4.83 ug/L (ppb) for DEA. No pesticide was detected at a level that exceeds the applicable standard.

Aquifer Vulnerability Study Summary

In addition to monitoring groundwater for the presence of agricultural chemicals, the SB 90-126 Program is required to determine the likelihood that an agricultural chemical will enter the groundwater. In the process of writing the generic Pesticide Management Plan (PMP), the staff at CDPHE, CDA, and CSU has studied various types of vulnerability analysis. In 1999, the legislature approved additional funding for a project to develop a method to determine aquifer vulnerability to both pesticides and nitrate statewide. In 2003, work continued toward this goal. Upon completion of the project, the program will be able to determine groundwater vulnerability to agricultural chemicals statewide.

Colorado State University

Education and Communication

Communication is a vital component of the program. Information is provided to individuals and organizations using agricultural chemicals as well as the general public through: written fact sheets; publications; newsletters; over the web (http://www.colostate.edu/Depts/SoilCrop/extension/WQ/); and through radio shows, mass media, press releases, and presentations at meetings throughout the state.

Ongoing BMP Development and Education

Colorado State University Cooperative Extension (CSUCE) has worked with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, landowners, and commercial agricultural chemical applicators. Because of the site-specific nature of groundwater protection, the chemical user must ultimately determine the BMPs adopted for use at the local level. The local perspective is also needed to evaluate the feasibility and economic impact of these practices. The SB 90-126 Advisory Committee has recommended that a significant level of input be received at the local level prior to adoption of recommended BMPs. Building on these efforts, a crop specific BMP, *Best Management Practices for Colorado Corn*, was published in 2003.

Demonstration Sites and Field Days

The groundwater program at CSUCE works with crop producers, their advisors, fertilizer dealers, USDA NRCS, commodity groups, and local County Extension faculty, to demonstrate and evaluate new and existing production tools that may improve producer profitability and help protect groundwater. Field demonstration work in 2003 centered around helping growers improve water management to deal with the water shortages brought about by the drought.

Colorado Department of Public Health and Environment

The Colorado Department of Public Health and Environment (CDPHE) provided data analysis for and interpretation of the pesticide and nitrate well data collected during the 2003 field season. The CDPHE also aided in planning the proposed installation of a monitoring well network in the Arkansas Valley of Colorado.

Objectives for 2004 Determined

The following objectives for 2004 have been established:

- Continue production of a report on ground water quality status in Colorado, educational efforts to address water quality problems, and the history of the 126 program;
- Continue demonstration and study plots in the South Platte River area for displaying improved nitrogen and water management to farmers;
- Work with Cooperative Extension field faculty throughout Colorado to demonstrate irrigation and nitrogen management BMPs;
- Coordinate with other agencies and non-governmental organizations to deal with water quality issues throughout the state;
- Continue BMP education work in vulnerable groundwater areas of Colorado;
- Continue the distribution of BMP materials on the economic considerations of BMP adoption for nutrient and pest management;
- Continue to develop and update educational resource materials for groundwater education;
- Publish, distribute, and display on the web, urban BMPs to encourage improved agricultural chemical and water management in urban areas;
- Continue to hold in-service training for chemical applicators, agency personnel, etc.;

- Participate in the Certified Crop Advisor program;
- Continue performing inspections of facilities requiring compliance with containment regulations;
- Continue to provide information on and enforcement of the containment rules and regulations;
- Continue collection and analysis of groundwater samples for pesticides and nitrates on a regional scale;
- Continue the long term monitoring program in Weld County by collecting and analyzing groundwater samples for pesticides and nitrates;
- Conduct statistical trend analysis on Weld County long-term monitoring data;
- Evaluate and validate the sensitivity analysis and vulnerability models developed for Colorado groundwater;
- Analyze data and publish results of the 2001-2002 BMP survey;
- Continue disseminating information on the Act and groundwater protection to special interest groups in Colorado;
- Continue revising, publishing, and distributing fact sheets relevant to the 126 program;
- Improve, update, and continue using the display board to provide information on the program at trade shows and professional meetings;
- Update the rules and regulations for bulk storage and mixing and loading facilities;
- Cooperate with the USGS on Phase II of the South Platte NAWQA;
- Collaborate with the USGS on groundwater monitoring in the Northern High Plains NAWQA;

- Complete monitoring well installation project in the Arkansas Valley of Colorado;
- Revise bulletin on pesticide fate and transport;
- Participate in USDA PDP program; and
- Begin work on producing a web-based pesticide and groundwater quality information tool.

APPENDICES

TABLE OF CONTENTS

APPENDIX I

2003 Annual Report
Colorado Department of Agriculture

Rules and Regulations for Agricultural Chemical Bulk Storage Facilities and Mixing and Loading Areas

Section 25-8-205.5 (3)(b) of the Agricultural Chemicals and Groundwater Protection Act requires the Commissioner of Agriculture to develop regulations where pesticides and fertilizers are stored or handled in quantities that exceed the established thresholds. These regulations were adopted in July 1994 and became effective September 30, 1994. The law mandated at least a three-year phase-in period for the regulations. As a result of comments prior to and at the public hearings, a graduated phase-in schedule was adopted.

Regulation of pesticide secondary containment/storage facilities and mixing and loading pads, and for liquid fertilizer tanks greater than 100,000 gallons (one of three prescribed methods of leak detection must be utilized unless secondary containment is in place) began on September 30, 1997. Regulation of fertilizer secondary containment/storage facilities and mixing and loading pads began on September 30, 1999. Compliance is required by:

- **September 30, 2004** for secondary containment for fertilizer storage tanks with a capacity greater than 100,000 gallons.

During 2003, facilities were visited to provide information and answer specific questions regarding the rules and regulations for bulk storage and mixing/loading facilities. This educational process aids individuals in determining first, whether or not compliance with the regulations is required and second, what specifically must be accomplished to meet the requirements.

Pesticide and fertilizer facility inspections continued in 2003. A total of 19 pesticide secondary containment structures and 37 mixing/loading pads were inspected. A total of 47 fertilizer secondary containment structures and 47 mixing/loading pads were also inspected. Five leak detection inspections were conducted for facilities storing fertilizer in tanks larger than 100,000 gallons. In addition, 46 follow-up inspections were conducted to correct problems noted a previous facility inspections. Three Cease and Desist Orders and three Violation Notices were issued during 2003; modifications were needed at some sites. In addition, 34 follow-up inspection orders were issued for problems at facilities that were not serious enough at this time to warrant a Cease and Desist Order or Violation Notice. Inspection of pesticide and fertilizer facilities will be ongoing during 2004.

One requirement of the regulations is that the facility design be signed and sealed by an engineer registered in the state of Colorado; or the design be from a source approved by the Commissioner and available for public use. The Colorado Department of Agriculture (CDA) in conjunction with Dr. Lloyd Walker, extension agricultural engineer with Colorado State University Cooperative Extension, has produced a set of plans that meet the second criteria. The document is entitled, Agricultural Chemical Bulk Storage and Mix/Load Facility Plans for Small to Medium-Sized Facilities. The plans are available from Colorado State University or CDA free of charge. The Colorado Department of Agriculture, in conjunction with CSU, has developed a set of generic plans for steel containment facilities to compliment the previously mentioned publication which focuses only on concrete.

Copies of the complete regulations and a summary sheet that contains a checklist to allow individuals to determine if the regulations apply to their operation are also available from CSU, CDA, or via the internet at www.ag.state.co.us/DPI/GroundWater/home.html.

Pesticide Registration and Groundwater Protection

The program continues to review products for registration in Colorado which have groundwater label advisories and advise the Department's registration program on the merits of registering these products.

Pesticide Management Plan

In October of 1991, the EPA released their Pesticides and Ground Water Strategy. The document describes the policies, management programs, and regulatory approaches that the EPA will use to protect the nation's groundwater resources from risk of contamination by pesticides. It emphasizes prevention over remedial treatment. The centerpiece of the Strategy is the development and implementation of Pesticide Management Plans (PMPs) for pesticides that pose a significant risk to groundwater resources.

The EPA will require a PMP for a specific pesticide if: (1) the Agency concludes from the evidence of a chemical's contamination potential that the pesticide "may cause unreasonable adverse effects to human health or the environment in the absence of effective local management measures;" and (2) the Agency determines that, although labeling and restricted use classification measures are insufficient to ensure adequate protection of groundwater resources, national cancellation would not be necessary if the State assumes the management of the pesticide in sensitive areas to effectively address the contamination risk. If the EPA invokes the PMP approach for a pesticide, its legal sale and use would be restricted to states with an EPA-approved PMP.

EPA published the proposed rule for Pesticide Management Plans on June 26, 1996. Comments on the proposed rule were submitted under the signature of the Commissioner of Agriculture, Director of Colorado State University Cooperative Extension, and the Executive Director of the Colorado Department of Public Health and Environment. These comments were printed in the 1996 report. To date, EPA has not published the final rule. It is uncertain when the document will be completed and what will be included based on the comments submitted. However, EPA is still requiring states to produce generic PMPs and is encouraging states to continue with groundwater protection programs as outlined the each state's PMP.

In 1996, a complete draft of the generic Pesticide Management Plan was finished and provided to EPA for their informal review. A redrafted, general Pesticide Management Plan based on EPA's comments on previous versions was submitted in January 1998. Comments on this version were received from EPA in April 1998, and Colorado then submitted a document final in August 1998 for formal review and concurrence. Two subsequent documents were submitted to EPA based on comments received, the last being in January of 2000. EPA concurred on Colorado's Generic Pesticide Management Plan (PMP) in March of 2000.

One of the more significant issues regarding the PMP involves EPA's demand for a sensitivity analysis/vulnerability assessment map of the state in a Geographic Information System (GIS) format, by which to determine where to focus education and monitoring activities. In late 1995, a small EPA grant was obtained to perform a sensitivity analysis pilot project for the northeastern part of the state. This work was completed in 1996 and provided to EPA. EPA reacted favorably to the project and provided funding for a statewide sensitivity analysis, which was completed in 1998. This information has been published in an eight page fact sheet titled Relative Sensitivity of Colorado Groundwater to Pesticide Impact. This publication assesses aquifer sensitivity based on four primary factors: conductivity of exposed aquifers; depth to water table; permeability of materials overlaying aquifers; and availability of recharge for the transport of contaminants. These factors were selected because they incorporate the best data currently available for the entire state and incorporate important aspects of Colorado's unique climate and geology.

In 1999, the SB 90-126 program was given spending authority to begin an aquifer vulnerability project to compliment and improve the existing aquifer sensitivity map. Work on one project on aquifer vulnerability to pesticides was completed June 30, 2001 with the Colorado School of Mines. Another related project titled *Probability of Detecting Atrazine/Desethyl-atrazine and Elevated Concentrations of Nitrate in Ground Water in Colorado*, done in conjunction with the United States Geological Survey (USGS) was completed in 2002. The program is continuing its work in this area and future projects are currently being planned based upon funding availability.

Waste Pesticide Disposal

In 1995, CSU Cooperative Extension operated a pilot waste pesticide collection program in Adams, Larimer, Boulder, and Weld counties. The purpose of this type of program is to provide pesticide users an opportunity to dispose of banned, canceled, or unwanted pesticides in an economical and environmentally sound manner. Part of the funding for the program was provided by an EPA Nonpoint Source 319 grant. The program was a success. Approximately 17,000 lbs. of waste pesticides from 67 participants were collected and safely disposed.

Based on the success of this pilot program, CDA was asked to continue a program that could collect and dispose of waste pesticides in other areas of the state. However, CDA currently has no statutory authority or funding to operate such a program. In light of this, two alternatives were discussed as a way for a waste pesticide collection program to continue. The first was for CDA to seek statutory authority and funding from the Legislature to operate a state-run program. The second was to determine if a private program, operated by a hazardous waste handling company, was possible.

The EPA and the Colorado Department of Public Health and Environment made the possibility of continuing a waste pesticide disposal program significantly easier by the passage of the Universal Waste Rule (UWR) in late 1995. The UWR was developed to encourage disposal of products identified as universal wastes by relaxing the regulations in the Resource Conservation and Recovery Act (RCRA) and therefore making it easier to properly dispose of these products. Waste pesticides were defined in the rule as a universal waste.

CDA spoke to hazardous waste contractors to determine if they would be interested in attempting to collect and dispose of waste pesticides as a private program. One company, MSE Environmental Inc., stated they would be interested. Discussions were initiated with the company and it appeared it would be possible for MSE to operate a private program at a reasonable cost to the participants. The collection and disposal costs for participants would be between $2.25 and $2.65 a pound.

Based on this information, it was determined that the private program option would be pursued since the possibility of getting legislation passed was slim. Furthermore, the time required for legislation to be passed would considerably delay the operation of a program.

After numerous issues were addressed, MSE targeted two areas of the state to initiate the program, the San Luis Valley and six counties in northeastern Colorado. Registration for participants was set to begin in early 1997, with a scheduled collection of pesticides set for mid-March 1997. This program was very successful. Over 10,500 lbs. of waste pesticides were collected from 33 participants. The cost to participants was $2.65 per pound.

Based on the success of this program, MSE conducted a statewide collection program in November 1997. Over 23,000 lbs. of waste pesticides were collected from 75 participants. Again the cost was $2.65 per pound. Subsequent programs are as follows:

Year	Pesticides Collected (lbs.)	Number of Participants
1998	0	0
1999	19,792	47
2000	0	0
2001	13,486	34
2002	8,762	33
2003	2,254	7

Legislation

The program personnel have proposed legislation regarding changing the program's fee structure. Due to the effects of both drought and the economy, program revenues have declined over the last several years. This has necessitated cuts in both personnel and operating expenses that are adversely affecting the way the program is operated. After 13 years at the current funding levels, a fee increase is necessary in order to effectively implement this program.

The first step in this process is asking the Legislature to remove the program fees from statute and allow the Colorado Agricultural Commission to set the fees. Currently, fees for the Department's other pesticide programs are approved by the Agricultural Commission. This includes the pesticide manufacturer's state registration fee of $95 per product, from which the groundwater program currently receives $20. Having the groundwater program's fee setting structure similar to other related programs is desirable and will give this program more flexibility to deal with future budget issues.

The program's request for this legislation during 2003 was not approved. A similar request will be proposed during 2004 and if approved, introduced during the 2005 legislative session.

Groundwater Monitoring

Summary of Accomplishments:

- Continued the long term monitoring project in the Weld County portion of the South Platte River Basin, a high priority watershed for SB 90-126 efforts. This year the sampling program sampled 19 monitoring wells and 50 irrigation wells.

- Developed a plan for the installation of a network of dedicated monitoring wells to be installed in the Arkansas Valley in 2004.

- Cooperated in a joint project with the U.S. Geological Survey, NAWQA program for the High Plains in an assessment of pesticides in the vadose zone overlying the Ogallala Aquifer.

- Cooperated with the U.S. Geological Survey, NAWQA program for Phase II of the South Platte Survey.

- Collaborated with Colorado State University researchers on the refinement of a statewide aquifer sensitivity map and vulnerability model for nitrate.

- Collaborated with the Department of Agriculture Standards Laboratory to revise and refine the laboratory analysis used on all ground water samples. Evaluated the pesticide survey data to extract information needed to improve laboratory analysis.

- Continued the project to automate data retrieval and report production utilizing the Access database for the entire program's ground water data storage and retrieval needs.

- Addressed groups throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed included chemical dealers, groundwater management districts, crop and livestock producers, and agency personnel.

- Distributed fact sheets and reports on Colorado groundwater quality to interested parties and fielded questions by phone and e-mail from Colorado citizens.

- Cooperated with County Extension agents on disseminating information about Colorado groundwater quality.

- Worked to coordinate efforts of the Agricultural Chemicals and Groundwater Protection program with other state and federal programs in Colorado.

- Cooperated and provided assistance to the South Platte BMP workgroup.

Weld County Long Term Monitoring

In 2003, the program completed the ninth year of a long term monitoring effort in the South Platte alluvial aquifer from Brighton to Greeley. The long-term monitoring network was established in 1995 and is a combination of three types of wells designed to sample a complete cross-section of the aquifer (Figure 1). The network well types are: a) 20 dedicated monitoring wells operated by the Central Colorado Water Conservancy District; b) 60 irrigation wells that were previously sampled in 1989, 1990, 1991, 1994; and c) 18 domestic wells first sampled in 1992. The monitoring and irrigation wells are sampled each year; the domestic wells every three years.

From June through August 2003, 69 wells in the long-term network were sampled. All wells were analyzed for nitrate-nitrite as nitrogen. The 19 monitoring wells were analyzed for the complete suite of 47 pesticides listed in Table 4. The pesticide analysis for the 50 irrigation wells was an immuno assay screen for the triazine herbicides.

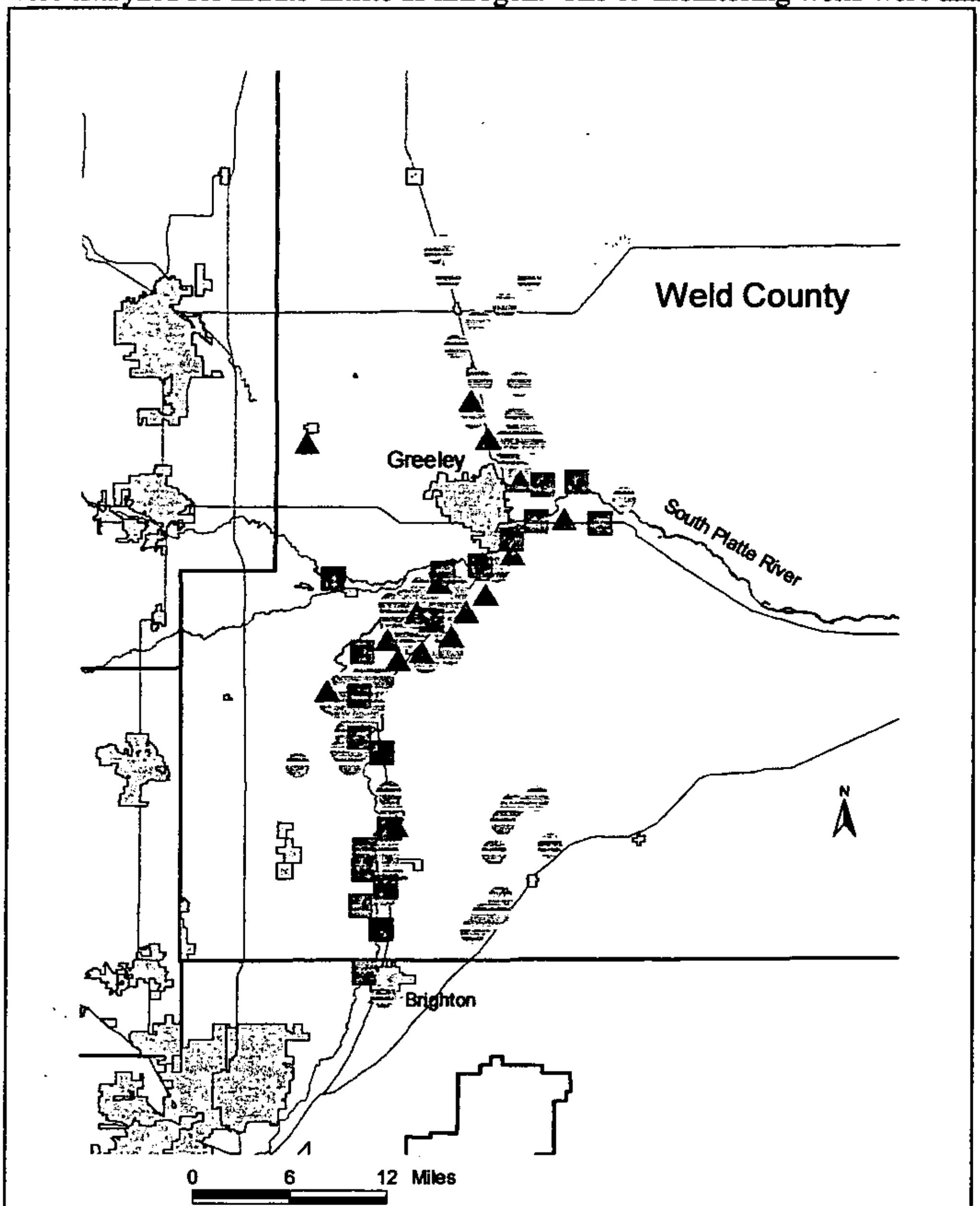


FIGURE 1 - Location and type of well comprising the Weld County, Colorado long term monitoring network.

Nitrogen analysis indicated that 63% of the monitoring wells and 66% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels varied over a broader range, with the highest median value. The monitoring wells sample the upper most zone (10 feet) of the aquifer. The irrigation wells recorded a narrower range in nitrate levels and a smaller median value. The differences are expected due to the different zones of the aquifer sampled by each well set, as the irrigation wells sample the entire saturated zone. Table 1 below, lists the summary statistics for both sets of wells.

TABLE 1 - Summary statistics for the Weld County nitrate monitoring results, 2003.

Weld County Nitrate Monitoring			
	Monitoring wells		Irrigation wells
Mean	25.2		19.4
Median	20.3		16.8
Standard Deviation	25.8		16.5
Minimum	2.4		< 0.01
Maximum	111		82
# Wells sampled	19		50
Note: all values are Nitrate as N (mg/L), except # wells			

Pesticide results for the monitoring well portion of the network revealed two pesticides, Atrazine and Metolachlor present in the Weld County monitoring well samples. The breakdown product of Atrazine, Deethyl Atrazine, was also detected. Atrazine was present in two wells and Deethyl Atrazine was also present in two of the wells. One well contained both triazine compounds. Metolachlor was detected in two other wells. Detection levels ranged from 0.58 for Metolachlor to 1.27 ug/L (ppb) for DEA. No pesticide was detected at a level that exceeds the applicable standard.

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, Deisopropyl Atrazine, and Prometone. The results are calibrated in units of Atrazine equivalent but may be actually composed of one or more of the components. In 2003, triazine herbicides were detected in 76% of the irrigation wells, an increase from the 63% detected in 2002. Levels ranged from 0.06 ug/L to 0.61 ug/L (ppb).

Brad Austin of CDA sampled the monitoring wells in Weld County during June 2003, and the irrigation wells in Weld County, from July through August 2003. Field sampling procedures followed the protocol developed by the ground water quality monitoring working group of the Colorado Nonpoint task force.

Table 2 - Laboratory Methods and Detection Levels, 2003

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

Pesticide Trade Name	Pesticide Common Name (ug/L)	Pesticide Use	Chemical Type	EPA Method	MDL
Harness	Acetachlor	Herb	acetoalinide	525.1	0.1
Lasso	Alachlor	Herb	OrganoCL	525.1	0.1
AAtrex	Atrazine	Herb	Triazine	525.1	0.1
	Deethyl Atrazine		Triazine	525.1	0.2
	Deisopropyl Atrazine		Triazine	525.1	0.2
Balan	Benfluralin	Herb	OrganoFL	525.1	0.2
Hyvar	Bromacil	Herb	uracil	525.1	0.4
Captane	Captan	Fungi	carboximide	525.1	1.4
Lorsban	Chlorpyrifos	Insect	OrganoPH	525.1	0.1
Bladex	Cyanazine	Herb	Triazine	525.1	0.2
Dacthal	DCPA	Herb	phthalic acid	525.1	0.1
Dazzel	Diazinon	Insect	OrganoPH	525.1	0.2
Barrier	Dichlobenil	Herb	nitrile	525.1	0.1
Cygon	Dimethoate	Insect	OrganoPH	525.1	0.5
	p,p-DDT	Insect	OrganoCL	525.1	0.4
	Endrin	Insect	OrganoCL	525.1	0.3
	Heptachlor	Insect	OrganoCL	525.1	0.6
	Heptachlor epoxide	Insect	OrganoCL	525.1	0.8
Velpar	Hexazinone	Herb	Triazine	525.1	0.1
Gamma-mean	Lindane	Insect	OrganoCL	525.1	0.1
Malathion	Malathion	Insect	OrganoPH	525.1	0.1
Ridomil	Metalaxyl	Fungi	acylalanine	525.1	0.2
Marlate	Methoxychlor	Insect	OrganoCL	525.1	0.9
Dual	Metolachlor	Herb	acetamide	525.1	0.1
Sencor	Metribuzin	Herb	Triazine	525.1	0.5
Prowl	Pendimethalin	Herb	dinitroaniline	525.1	1.2
Primatol	Prometon	Herb	triazine	525.1	0.1
Princep	Simazine	Herb	triazine	525.1	0.2
Treflan	Trifluralin	Herb	OrganoFL	525.1	0.3
Weed B Gone	2,4-D	Herb	PhenoxyAcid	515.2	0.03
Stinger	Clopyralid	Herb	PicolinicAcid	515.2	0.07
Banvel	Dicamba	Herb	BenzoicAcid	515.2	0.05
Kilprop	MCPP	Herb	PhenoxyAcid	515.2	0.06
Agritox	MCPA	Herb	PhenoxyAcid	515.2	0.02
Tordon	Picloram	Herb	PicolinicAcid	515.2	0.17
Turflon	Triclopyr	Herb	PicolinicAcid	515.2	0.01

Table 2, continued - Laboratory Methods and Detection Levels, 2003

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

Pesticide Trade Name	Pesticide Common Name (ug/L)	Pesticide Use	Chemical Type	EPA Method	MDL
Temik	Aldicarb	Insect	Carbamate	531.1	1.0
	Aldicarb sulfone		Carbamate	531.1	2.0
	Aldicarb sulfoxide		Carbamate	531.1	2.0
Sevin	Carbaryl	Insect	Carbamate	531.1	2.0
Furadan	Carbofuran	Insect	Carbamate	531.1	1.5
	3-Hydroxycarbofuran		Carbamate	531.1	2.0
	Methiocarb	Insect	Carbamate	531.1	4.0
Lannate	Methomyl	Insect	Carbamate	531.1	1.0
	1-Naphthol		Carbamate	531.1	1.0
DPX	Oxamyl	Insect	Carbamate	531.1	2.0
Baygon	Propoxur	Insect	Carbamate	531.1	1.0

INORGANIC ANALYSIS

	(mg/L)	EPA Method	MDL
Nitrate/Nitrite as N		300	0.1

Table 2, continued - Laboratory Methods and Detection Levels, 2003

Colorado State University Soils Laboratory

MINERALS AND DISSOLVED METALS ANALYSIS

Basic Water Quality Parameters (mg/L)	**Method**	**Reporting Limit**
Boron	EPA 200.0	0.01
Bicarbonate	APHA 2320B	0.1
Calcium	EPA 200.0	0.1
Carbonate	APHA 2320B	0.1
Chloride	EPA 300.0	0.1
Magnesium	EPA 200.0	0.1
Nitrate	EPA 300.0	0.1
pH	EPA 150.1	0.1 pH unit
Sodium	EPA 200.0	0.1
Specific conductance (TDS)	EPA 120.1	1.0 uS/cm
Sulfate	EPA 300.0	0.1
Potassium	EPA 200.0	0.1
Alkalinity, total	Titration	1.0
Solids, Total Dissolved	Gravimetric	10.0
Hardness, total as $CaCO_3$	Calculation	1.0
Dissolved Metals		
Aluminum	EPA 200.0	0.1
Barium	EPA 200.0	0.01
Cadmium	EPA 200.0	0.01
Chromium	EPA 200.0	0.01
Copper	EPA 200.0	0.01
Iron	EPA 200.0	0.01
Manganese	EPA 200.0	0.01
Nickel	EPA 200.0	0.01
Molybdenum	EPA 200.0	0.01
Phosphorous, total	EPA 200.0	0.1
Zinc	EPA 200.0	0.01

Determination of Monitoring Well Locations and Rational for Selection

The Agricultural Chemicals and Ground Water Protection Act enacted by the Colorado Legislature in 1990 (SB 90-126) established responsibility for the Agricultural Chemicals and Ground Water Protection Program to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. This data assists the Commissioner of Agriculture in determining whether agricultural operations are impacting ground water quality.

<u>Review of Existing Monitoring Data</u>

The program has collected ground water quality data in Colorado since its inception in 1991. Over 1,500 samples from 915 wells have been collected and analyzed for pesticides, nitrate, basic ions, and dissolved metals (Figure1). The first step in determining locations for new monitoring wells was a review of existing data collected by the program and those other sources readily available.

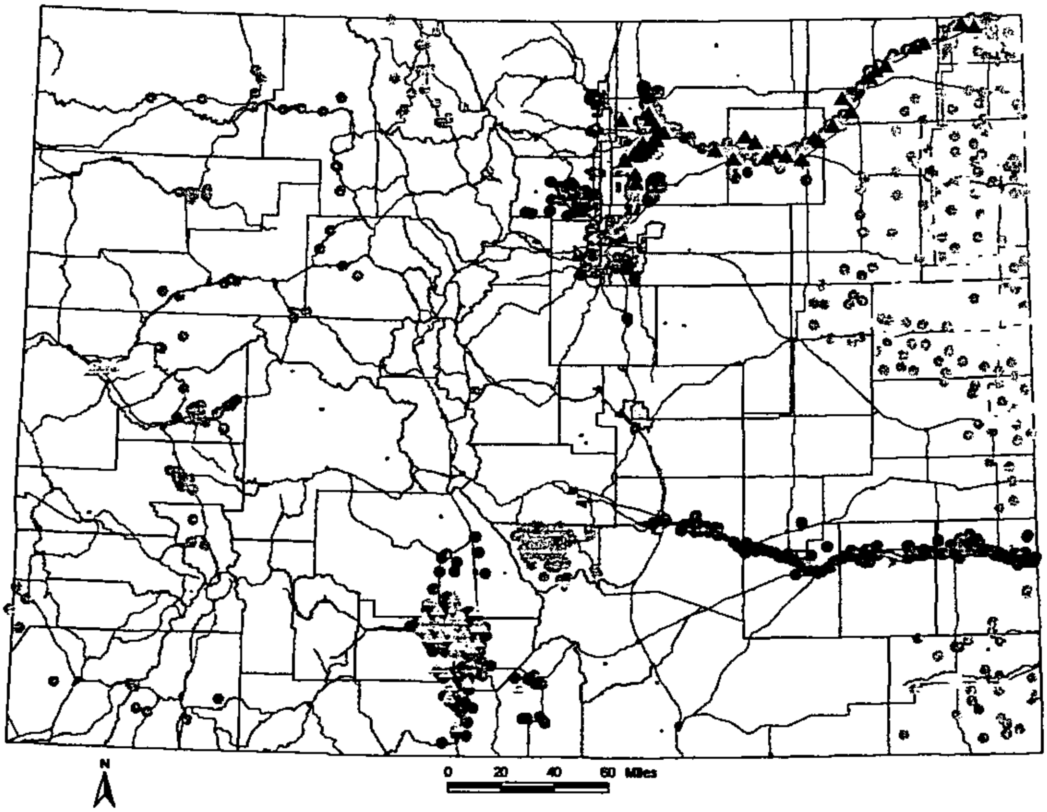


Figure 1 – Location of wells sampled by the Agricultural Chemicals and Ground Water Protection Program in Colorado, 1992 – 2002.

The majority of ground water monitoring to date has concentrated on the major agricultural regions of Colorado. In the early years of the monitoring program, areas and wells selected for monitoring were based on a combination of land use and hydrogeologic factors. The predominant land-use factors were: significant agricultural chemical use in the area; no known point sources of contamination; and the presence of irrigation. Priority was given to shallow alluvial aquifers collocated with major agricultural land use. The wells selected for monitoring were based on a combination of factors with priority given to domestic use classification, depth to water less than 50 feet, and wellhead condition. Existing domestic, stock, and irrigation wells were selected for monitoring when available to hold down cost and meet sampling schedules. The problems associated with using these types of existing wells are well known. Proper planning combined with careful well selection can minimize these problems, but in some cases the nature of this approach creates unavoidable uncertainties in the data.

The following two figures (Figures 2 & 3) present a summary of results over the ten-year period 1992 - 2001. Those wells testing for nitrate as nitrogen (NO_3-N) at or over 10 mg/l (EPA drinking water standard) are plotted in Figure 2.

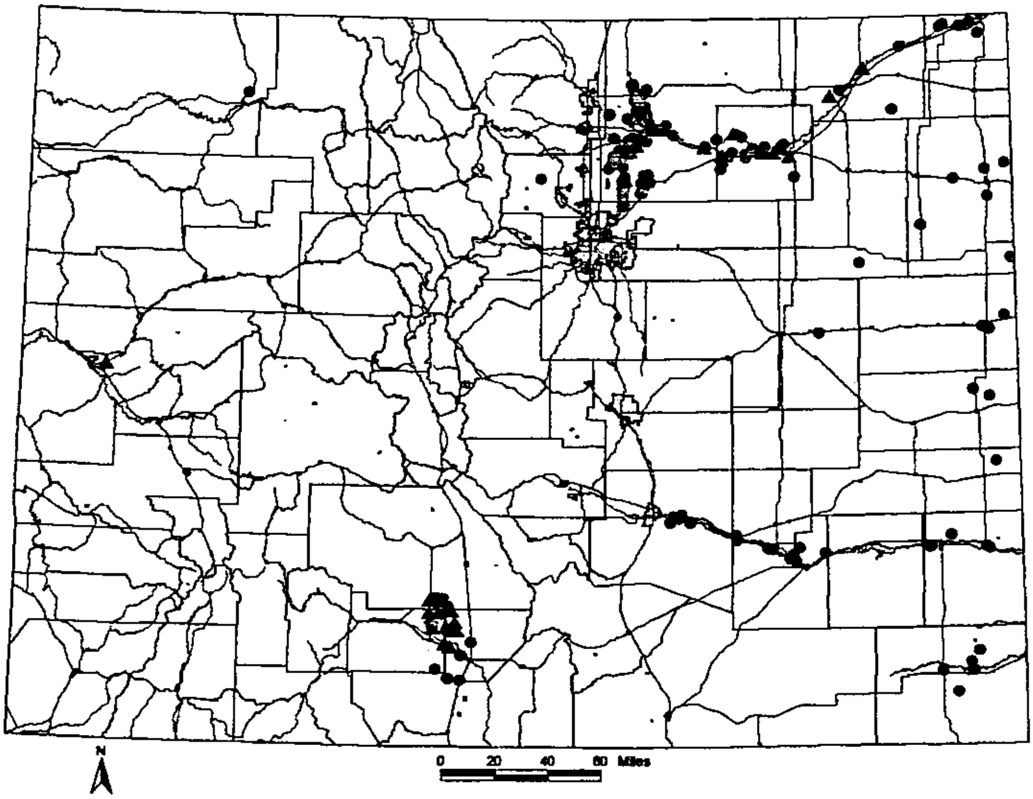


Figure 2 – Location of wells with nitrate as nitrogen (NO_3-N) at a level of 10 mg/l or greater, sampled 1992 – 2001.

Of the 915 wells sampled in this period, 181 or 20% exceeded the standard. The majority of these exceedences occurred in the South Platte River alluvial aquifer. The San Luis Valley unconfined aquifer had the second most exceedences. This result was not unexpected as these two regions are intensive agricultural production areas that overly major shallow ground water aquifers. The aquifer sensitivity map presented later in this report also shows both areas rank from moderate to highly sensitive.

Wells testing positive for a pesticide at any level are shown below in Figure 3. One hundred and fifty-two (152) wells from the 915 sampled for pesticides (17%) have a pesticide present.

The majority of pesticide detections in Colorado have been the herbicide Atrazine or one of its breakdown products Desethyl Atrazine or Desisopropyl Atrazine. The second most commonly detected pesticide is the herbicide Prometone. The majority of pesticide detections occur in the 0.1 to 1.0 ug/l (ppb) range. In seven of the wells tested, a pesticide level has exceeded the established standard for that pesticide.

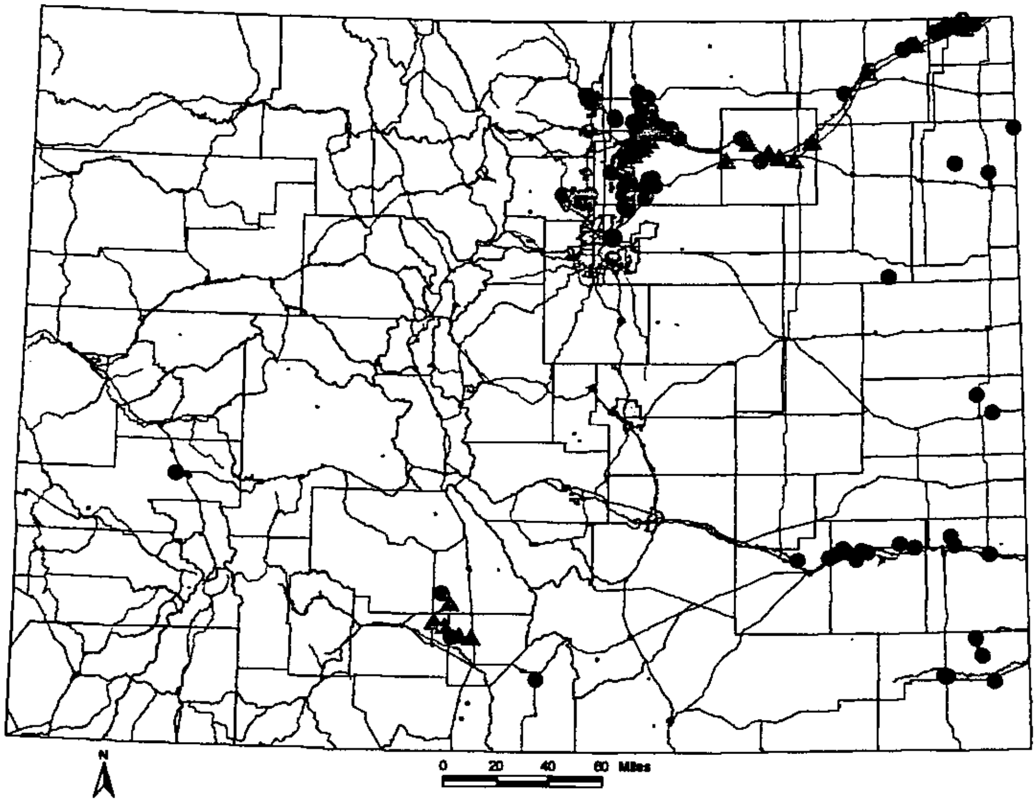


Figure 3 – Location of wells with a pesticide detection, sampled 1992 – 2001.

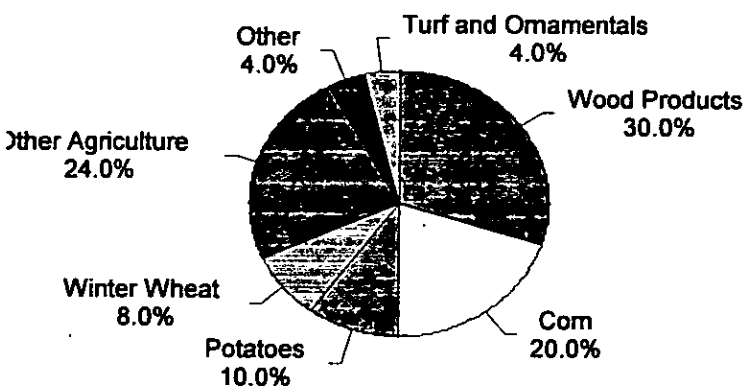


Figure 4 – Pesticide use in Co.

As is the case with nitrate exceedences, the South Platte River alluvial aquifer accounted for the majority of pesticide detections. The Arkansas River alluvial aquifer ranked second in pesticide detections. In both cases, levels were low (less than 1.0 ppb) but detections occurred throughout the areas.

Pesticide Use Survey

In 1997, 82.8 million ounces of pesticides were applied in Colorado. Agricultural related applications consisted of 51.2

million ounces, or 62% of all pesticides applied (Figure 4). The largest amount of pesticides, 24.3 million ounces, was applied to wood products. The second largest amount, 16.9 million ounces, was applied to corn crops. The third largest amount, 16.7 million ounces, was applied in other agricultural uses, the majority on other crops. The fourth and fifth largest amounts, 8.3 million and 6.8 million ounces, were applied to potatoes and winter wheat respectively. Colorado's commercial and private agricultural applicators treated 4.6 million acres with pesticides in 1997.

Adams County was reported to have the largest amount of chemicals applied, due to the large amount of wood products treated with creosote. The Front Range Region accounts for 44%, 36.3 million ounces, of the pesticides applied in the state, due largely to Adams County (Table 1). The Eastern Plains Region comes in second at 20.0 million ounces, or 24% of Colorado's pesticide applications. Weld County and Yuma County, second and third to Adams County respectively, comprise 14%, or 11.5 million ounces, of the state's total amount of pesticides applied. Private agricultural applications, or 15.8 million ounces, are not included in Table 1 because county data for these applications was not available.

Table 1 - Regional Totals of Pesticide Use in Colorado (1997)

Region	**Total Ounces Applied**	**Percent of Total**
Front Range	36,332,854	44%
Eastern Plains	20,065,971	24%
San Luis Valley	7,049,073	9%
Western Slope	3,527,822	4%
Central	40,840	0%
Unknown	12,141	0%
State Total	**82,786,506**	**100%**

If we factor out the industrial and commercial use in structural applications of pesticides, we can look at the broad based production agricultural application of pesticides in Colorado. Upon doing this, we see a geographic distribution best illustrated by Figure 5 below. Although this graphic shows only Metolachlor use, it serves well as a surrogate for total agricultural pesticide use in Colorado.

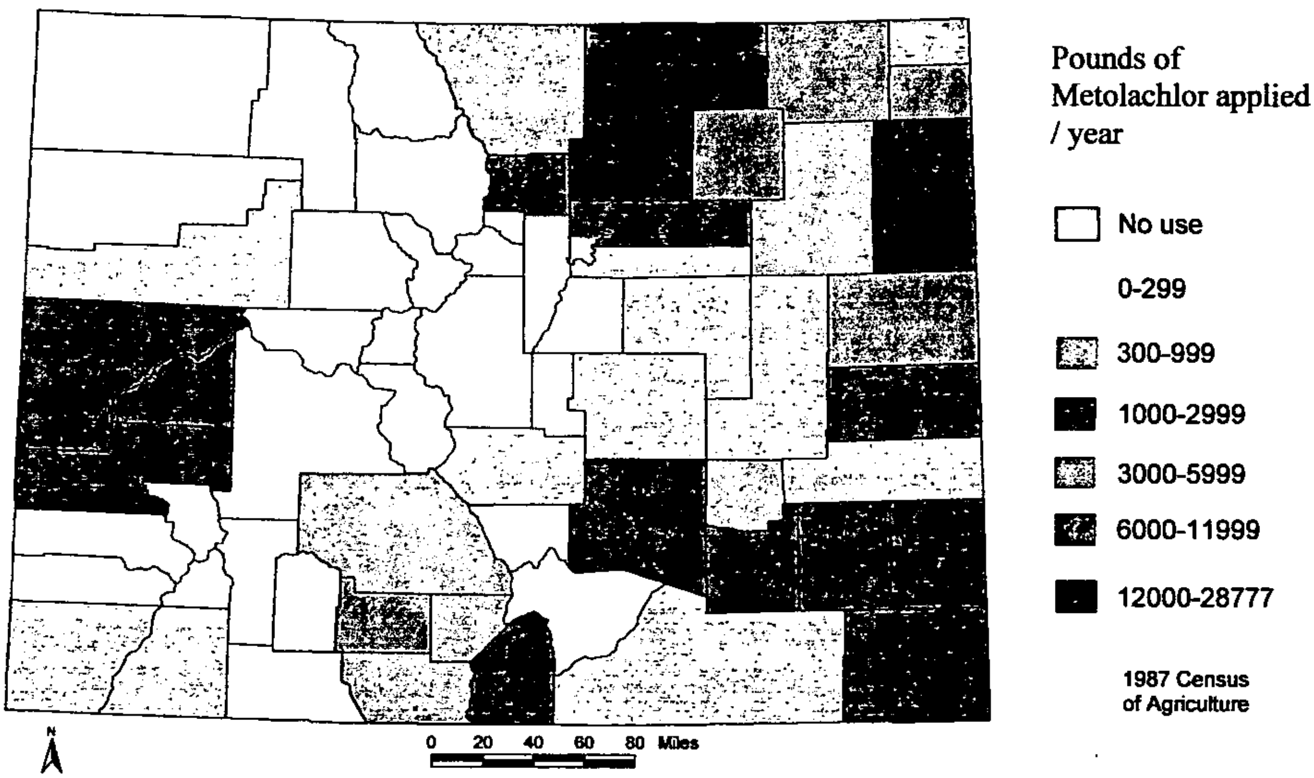


Figure 5 – Map showing the distribution of Metolachlor use in Colorado.

In Figure 5, we can see that five major agricultural production areas account for the majority of production agricultural use of pesticides in Colorado. Those five areas, the South Platte River basin, San Luis Valley, Lower Arkansas River basin, and the Uncompahgre, Gunnison, and Lower Colorado Rivers area (tri-river area) have been sampled at least once by the program (Figure 1). Of the five, our sampling density is the weakest in the tri-rivers area.

Aquifer Sensitivity and Vulnerability Models

In addition to monitoring ground water for the presence of agricultural chemicals, the Ag Chemicals Program is required to determine the likelihood that an agricultural chemical will enter the ground water. This determination is based upon the chemical properties of the chemical in question, the behavior of a particular chemical in the soil types of the region under study, the depth to ground water, the farming practices in use, and other factors. This type of determination has been described as a vulnerability analysis.

"Sensitivity" is used by this program as defined by EPA to mean "the relative ease with which a contaminant (in this case a pesticide) applied on or near a land surface can migrate to the aquifer of interest. Aquifer sensitivity is a function of the intrinsic characteristics of the geologic materials in question, any overlying saturated materials, and the overlying unsaturated zone. Sensitivity is not dependent on agronomic practices or pesticide characteristics."

Four primary factors were identified as critical in describing the sensitivity of ground water to pesticide contamination in Colorado:

Factor 1 - conductivity of exposed aquifers
Factor 2 - depth to water table
Factor 3 - permeability of materials overlying aquifers
Factor 4 - availability of recharge for transport of contaminants

These selected factors incorporate important aspects of Colorado's unique climate and geology. An indicator for each factor was chosen for use in calculating the overall aquifer sensitivity. Choice of these indicators required consideration of information availability, budget constraints, manpower availability, and management objectives.

Factor 1 - Conductivity of Exposed Aquifers

Availability of ground water in Colorado is highly variable. In agricultural regions of Colorado, a number of principal aquifers supply water for domestic uses, irrigation, and commercial uses. Between these primary aquifers are regions where ground water supplies are inconsistent and provide low yields. While scattered wells in these low-yield areas may provide important point sources for small volumes of water, the general conductivity of the aquifer materials is low and transport of contaminants is expected to be very slow. These primary aquifers represent highly valued ground water resources. Their relatively high conductivity leads to increased likelihood of transport of contaminants from source areas to points of use. Conductivity of these priority aquifers is highly variable but overall is much higher than the conductivity of water-bearing strata in the areas not underlain by one or more of these principal aquifers. Therefore, **the presence or absence of one or more of these principal aquifers** was selected as the indicator of high conductivity aquifer areas.

Factor 2 - Depth to Water Table

Depth to the water table clearly affects the length of time required for a possible contaminant to reach the ground water. Since reasonably extensive data on depth to water table is available, at least for the high conductivity aquifers of the region, **depth to water table is incorporated directly** into the sensitivity analysis.

Factor 3 - Permeability of Materials Overlying Aquifers

The permeability of the unconsolidated deposits overlying the aquifer (overburden) affect the susceptibility of the aquifer to contamination by determining the partition between infiltration and runoff of precipitation and irrigation. In addition, the character of the soil and vadose zone materials affects the time required for infiltrated water to reach the saturated ground water, an important consideration when dealing with chemicals such as pesticides that degrade in the environment. The overburden includes both the traditionally defined soil column and the vadose zone underlying uppermost soil layers. Unfortunately, spatially extensive information about the vadose zone is not available for much of Colorado. However, information describing the soils is available in different levels of detail. The State Soil Survey Geographic Database (STATSGO) offers a regional-scale description of soil groupings in digital form (NRCS, 1994) and was selected as the best currently available source of information on soil properties for the aquifer sensitivity analysis.

A number of soil characteristics related to permeability are included in the STATSGO database including overall soil texture, soil surface texture, particle size distribution, component layer permeability, and hydrologic group. The hydrologic group designation describes runoff generation potential of a soil series, and soils with high runoff potential will accordingly have low infiltration potential. Because the hydrologic group designation includes consideration of several factors important in controlling the infiltration rate of a soil, it is felt that it carries more information for an analysis at this scale than other single soil parameters. Therefore, the **hydrologic group designation was chosen as the best available representation of the permeability of materials overlying the aquifers**.

Factor 4 - Recharge Availability

The level of availability of infiltrating water for transport of contaminants to the ground water is an important consideration in Colorado's semi-arid climate. Average annual precipitation in Colorado's agricultural areas range from approximately 7 to 17 inches. Low precipitation, coupled with a high percentage of possible sunlight and low humidity, leaves little moisture available for infiltration and subsequent aquifer recharge. Irrigated agriculture and leakage from associated canals and reservoirs, however, provide additional water for infiltration and in most agricultural areas of Colorado, this is the primary source of recharge to the aquifers.

Due to the relative abundance of recharge under irrigated agriculture compared with the extremely limited natural recharge supply in Colorado's climate, **the presence or absence of irrigated agriculture was chosen as an indicator of recharge availability**.

GIS data layers were developed for each of the four indices described above. All layers were developed and the analysis was conducted at a grid resolution of 1 km, 0.62 mi. Based on data

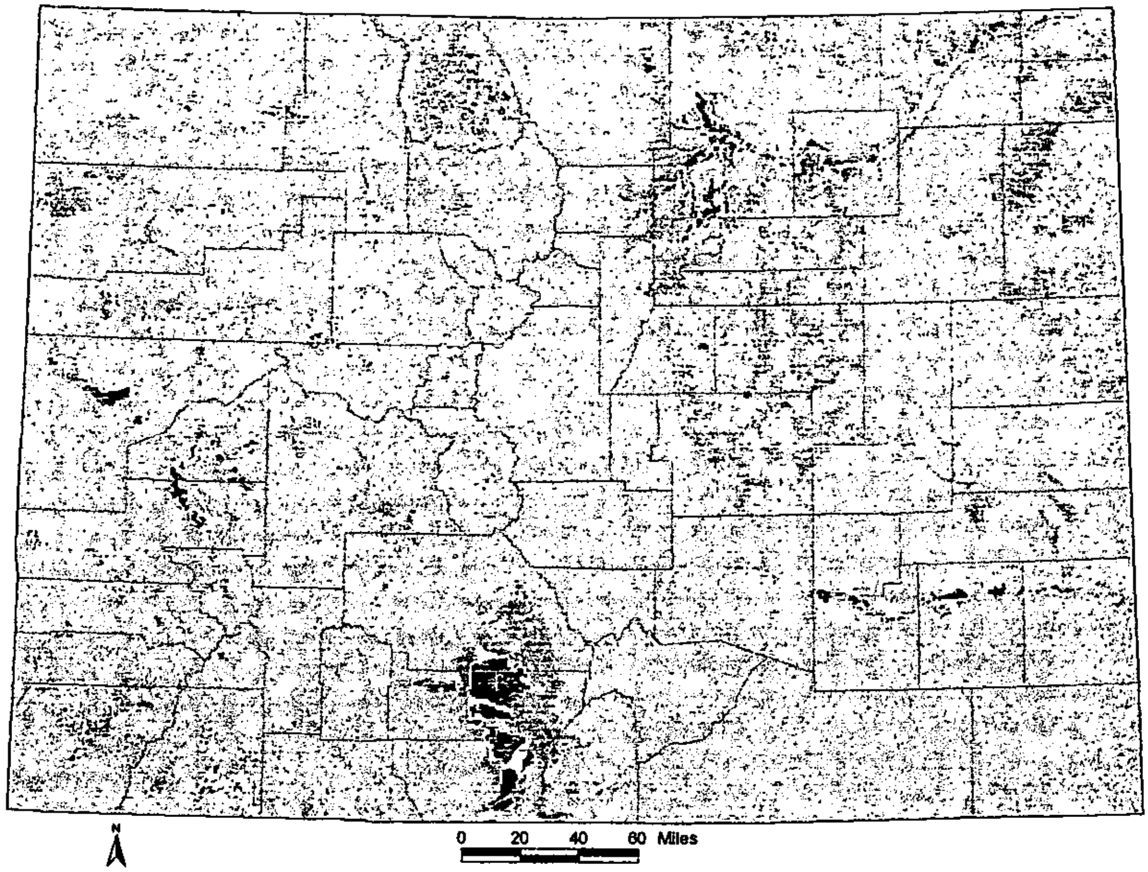


Figure 6 – Aquifer sensitivity to pesticide contamination in Colorado.

confidence and perceived importance of factors, the depth to water table was weighted more heavily than the soil permeability. The model yields a range of values; for ease of interpretation, this range was rescaled to obtain a sensitivity index shown on the sensitivity map in Figure 6.

Sensitivity values range from areas that are not irrigated and/or do not overlie conductive aquifers to high sensitivity representing areas where a very shallow water table in a highly conductive aquifer coincide with at least moderately permeable soils that receive irrigation.

The concept of this model and all data collection and analyses were conducted with the objective of a regional-scale assessment in mind. Single cell values are not used, and isolated cells of a particular value will be ignored in assessment of general trends in sensitivity. The information presented in the sensitivity map is used to support conclusions concerning regions on a minimum scale of tens of kilometers.

The sensitivity mapping project is intended as a general guide in identifying areas of the state in which ground water, due to its hydrologic and geologic setting, is more or less susceptible to contamination from agricultural activities. The analysis considers only hydrogeologic setting. No consideration of actual pesticide use, crop patterns, management practices, etc. was attempted. Therefore, the results of this analysis should be combined with knowledge of other factors, which contribute to the overall vulnerability of the resource in development of protection strategies, and management plans.

Justification for Monitoring Well Installation

The potential for false positive, and more importantly, false negative results due to the well selection methodologies adopted in past sampling efforts may not provide adequate characterization of pesticide contamination, or the potential thereof, in Colorado's groundwater.

The potential for false positive results exists because of substandard well construction or less than ideal sampling conditions. Inadequate well construction has been predominantly in the form of poor condition of the well casing or improper or missing grout. Well location, well depth, and permission to access land were the priorities in the well selection process in past studies. Wells with substandard well construction were intentionally included in these previous studies in an effort to establish if point source contamination due to poor well construction was a factor. Less than ideal sampling conditions encountered in the past sampling of irrigation wells include the lack of low-volume tap prior to injection (chemigation) point in irrigation wells, windy weather leading to blowing soil, and aerial application of agricultural chemicals on neighboring fields. In the case of domestic wells, the location and condition of the associated septic system was usually unknown and the freedom of influence from a spill was dependent on the well owner's memory. Descriptions of well construction, as evident at the surface, and sampling conditions were recorded at each site. Most of the potential for false positive results can be significantly reduced if sufficient time is allotted to project design and well selection.

False negative results are inherently probable in results of pesticide analysis performed on groundwater sampled from large capacity irrigation wells. Although almost all wells selected were under 100 feet in depth, the large screened intervals (averaging about 60-100 feet in most studies) and discharges of 800 – 1,200 gpm lead to considerable dilution of contaminants which most likely exist in the uppermost layers of the saturated zone. In addition, as groundwater is pumped and sampled at high discharge rates, volatilization of some organic compounds, including pesticides, is probable.

It should be noted that pesticide analysis of groundwater collected from high-capacity wells has become accepted practice. In addition to several major state sampling programs, EPA's recently completed National Pesticide Survey included many high-capacity wells.

Unlike the false positive potential described above, the possibility of false negative results cannot be reduced by expending additional resources on the well selection process. A redesign of the groundwater quality assessment program towards dedicated monitoring wells is recommended as an alternative. Although additional considerations are generated by the switch in well type, it is believed a more verifiable representation of groundwater contamination, or the potential for contamination, in groundwater can be determined.

Preliminary Monitoring Well Site Selection

The initial analysis of existing monitoring data, agricultural chemical use, and aquifer sensitivity and vulnerability models developed by the program has led to several preliminary site selections. Time and cost constraints as the drilling program progresses may require modifications in the number of locations.

The program has secured the cooperation from other agencies in Colorado for the use of several dedicated monitoring wells in its monitoring program. The South Platte River alluvial aquifer and the San Luis Valley unconfined aquifer currently have suitable monitoring well networks. This situation could change in the future of course, but at this time, we propose only an additional two wells in the South Platte drainage area to fill in existing gaps in that coverage.

The Arkansas River alluvial aquifer is currently lacking in monitoring well coverage and ranks third in our areas of concern. The details are not final at this time but we propose to drill at least eight, and possibly twelve monitoring wells in this region.

The Front Range urban corridor is an area we intend to continue monitoring for agricultural chemicals. The development density of this area creates special considerations for monitoring. The availability of existing domestic and irrigation wells is very limited. Current plans are to build a monitoring network from existing monitoring wells. There are currently hundreds of dedicated monitoring wells throughout the metropolitan area. The majority of these wells were installed for site investigations unrelated to agricultural chemicals. We hope to enlist the cooperation of monitoring well owners in this area and avoid the expense of additional drilling. However, if this effort fails, we will reserve funds to install our own monitoring wells.

The tri-river region on the west slope of Colorado needs a more detailed monitoring survey than existing wells can provide. We can improve our coverage (sampling density) only by installing dedicated monitoring wells. The funds available in this grant do not allow further work at this time, but if additional funds become available, this area will be added to the drilling program.

The specific monitoring well site selection criteria, used for these initial site selections, were similar to the criteria that have guided the monitoring program since its inception. To qualify, an area must have agricultural chemical use in significant quantities, depth to ground water less than 50 feet (both a vulnerability and drilling economics factor), a representative array of soil types, and a mixture of irrigated and non-irrigated land use.

Figure 7 shows the preliminary sites selected for the Arkansas River alluvial aquifer system, the area chosen for most of the monitoring well sites. The final monitoring well locations may be altered slightly due to local site conditions.

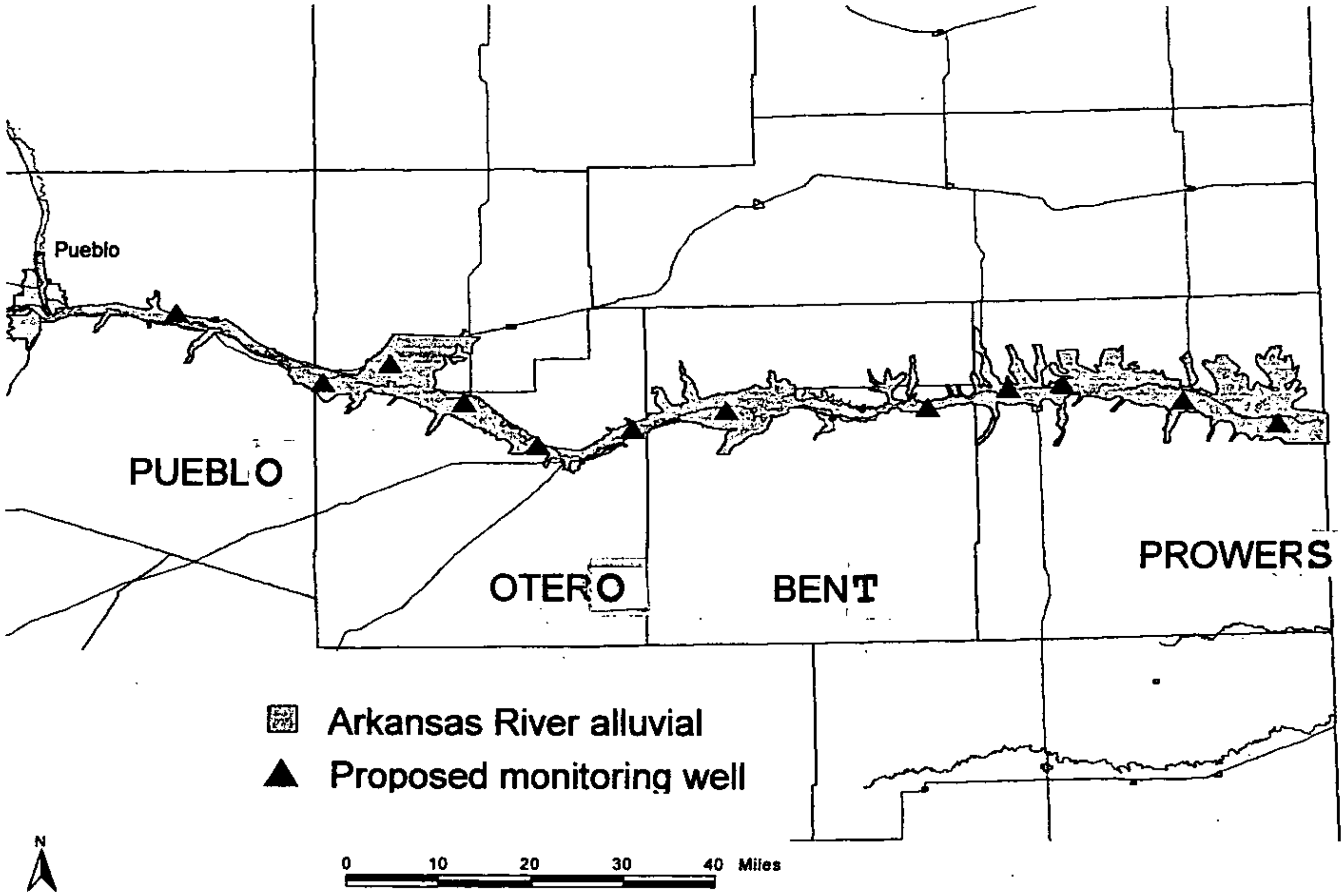


Figure 7 – Proposed monitoring well locations in the Arkansas River alluvial aquifer.

Well Installation and Sampling

A hollow-stem continuous flight auger will be used to drill all monitoring wells for which this method is applicable. All down hole drilling equipment will be decontaminated prior to and following drilling with double steam cleaning, liquinox, and dionized water rinse. During drilling, the cuttings will be logged at a five foot minimum interval. A rock core log will be utilized during any coring of the monitoring wells. Borehole sample/cuttings will be described and a borehole lithologic log will be prepared. Data that will be gathered for each drilled well will include: lithologic description and remarks, color, moisture, consistency, soil type, depth, method of sample collection and identification number, penetration resistance, ground water depth, perched water zones, borehole elevation, borehole diameter, date drilled, drill rig number, project identification, project location, drilling contractor, well identification, and well completion data. All measurements and activities will be documented in the field logbook. Well casings will be constructed of two inch schedule 80 ASTM-approved polyvinylchloride (PVC). Pipe sections will be flush threaded to prevent the introduction of contaminants such as glue or solvents into the well. Well casing and screens will be steam cleaned prior to emplacement to ensure that all oils, greases, and waxes have been removed.

Well Construction and Completion Procedures

It is anticipated that the shallower portions of the borehole may not stand open as the auger is retracted prior to the construction of the monitoring well. Therefore, the monitoring well will be constructed through the hollow axis of the auger column. When the auger column is used as a temporary casing during well construction, the hollow axis facilitates the installation of the monitoring well casing, intake, filter pack, and annular seal.

In summary, the following procedures will be adhered to:

The filter pack will extend from the bottom of the well screen to no more than two feet above the well screen.

The annular seal will be constructed by placing a stable, low permeability material in the annular space between the well casing the borehole wall. The annular seal will extend from the top of the filter pack to the bottom of the surface seal. Contaminant free water must be added to the bentonite when the seal is located above the water table.

A two-foot interval above the filter pack will be sealed with untreated sodium bentonite pellets. A bentonite-cement mixture will be used from the top of the bentonite pellet zone to the expanding cement surface seal. Expanding cement will be used for the remaining annular space to provide for security and an adequate surface seal. The location of the interface between the cement and the bentonite-cement mixture will be below the frost line. A weep hole will be drilled in the protective casing immediately above the cement inside the casing.

Upon completion of the well, a casing cap and lock will be installed to prevent the entrance of foreign material and tampering.

Well Development

Following the construction of the monitoring wells, natural hydraulic conductivity of the formation will be restored and all foreign sediment will be removed to ensure turbid-free ground water samples. Well development will not begin until the grout has properly set (at least 48 hours). All developing well equipment will be decontaminated prior to use with double steam cleaning, liquinox, and a final dionized water rinse.

Before initiating the well surging, the well will be bailed to make sure that water will flow into it. A mechanical method of development, a surge block, will be used to force water to flow into and out of the screen. Development will begin above the screen and move progressively downward to prevent the tool from becoming sand locked. Surging and cleaning will be continued until little or no sediment can be pulled into the well.

APPENDIX II

2003 Annual Report
Colorado State University Cooperative Extension

Summary of Accomplishments:

- Conducted educational programs throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed included commercial applicators, chemical dealers, weed districts, crop consultants, crop and livestock producers, agency personnel, real estate professionals, and urban chemical users.

- Produced newsletter articles, press releases, fact sheets, technical papers, radio and other mass media articles on ground water protection in Colorado.

- Conducted training related to the Colorado Best Management Practices Manual. Distributed booklets to Colorado citizens covering nutrient, pesticide, irrigation, manure, corn, pesticide record keeping, and private water well management.

- Cooperated with the Colorado Corn Growers Association (CCGA) to publish and print an 88-page corn production guide, Best Management Practices for Colorado Corn, XCM-574A for the CCGA EPA 319 program (Appendix IV). This publication was distributed to over 2,000 growers.

- Cooperated with field Extension staff to conduct irrigation management demonstrations on farmer fields throughout Colorado. Demonstrations included: using ET from atmometers and soil moisture measurement with Water Mark® sensors for improved irrigation scheduling; the effect of sprinkler nozzle height on corn yield, runoff and soil moisture under center pivot irrigation.

- Cooperated with Weld County farmer to demonstrate irrigation water nitrate crediting in farmer-managed field.

- Cooperated with the Colorado Climate Center to improve and promote the crop water use (ET) reports provided by the Colorado Agricultural Meteorological Network (CoAgMet). See www.CoAgMet.com.

- Analyzed and summarized data from returned surveys from a statewide Irrigated Crop Production Survey to assess the current level of BMP adoption by Colorado producers. The survey was mailed in late November 2001.

- Worked on the Certified Crop Advisors Program in Colorado, including revising the state performance objectives, conducting the state exam and working with the national exam review committee.

- Collaborated with Colorado staff of the Natural Resources Conservation Service to publish a Colorado Nitrogen Leaching Index (CONLI) Risk Assessment for use by farmers, consultants, and NRCS field staff.

- Cooperated with the USGS to publish a report on the groundwater vulnerability map for assessing nitrate and atrazine contamination potential for Colorado (Appendix IV).

- Maintained a CSU Extension Water Quality Website to disseminate BMP information via the Internet.

- Printed and distributed revised series of four fact sheets on the web to educate Colorado homeowners on BMPs for urban pesticide and fertilizer use (see appendix IV). These fact sheets are entitled:
  Homeowner's Guide to Protecting Water Quality and the Environment XCM-223
  Homeowner's Guide to Pesticide Use Around the Home and Garden XCM-220
  Homeowner's Guide: Alternative Pest Management for the Lawn & Garden XCM-221
  Homeowner's Guide to Fertilizing Your Lawn and Garden XCM-222

- Published a set of fact sheets on irrigation water quality and salinity management (http://www.ext.colostate.edu/pubs/crops/pubcrop.html#irr). These fact sheets are entitled:
  Irrigation Water Quality Criteria – CSUCE Fact Sheet 0.506
  Diagnosing Saline and Sodic Soils – CSUCE Fact Sheet 0.521
  Managing Saline Soils – CSUCE Fact Sheet 0.503
  Managing Sodic Soils – CSUCE Fact Sheet 0.504

- Distributed the revised Pesticide Record books for Private Applicators (Appendix IV).

- Distributed a booklet of BMPs specifically for greenhouse growers in Colorado entitled "Pollution Prevention for Colorado Greenhouses."

- Distributed a 20 minute instructional video entitled "Best Management Practices for Colorado Agriculture."

- Worked to coordinate efforts of the Agricultural Chemicals and Groundwater Protection Program with other state and federal programs in Colorado.

- Assisted the Colorado Department of Agriculture in locating wells for the USEPA-supported monitoring well drilling project in the Arkansas Valley.

- Assisted County Cooperative Extension faculty, consultants, and growers in dealing with the lingering drought conditions in 2003. This assistance included help with decisions on abandonment of irrigated acres, soil moisture monitoring for planting decisions, and improved water management advice for limited irrigation supplies.

Ongoing BMP Development and Education

Colorado State University Cooperative Extension (CSUCE) has worked with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, landowners, and commercial agricultural chemical applicators. Because of the site-specific nature of groundwater protection, the chemical user must ultimately determine the BMPs adopted for use at the local level. The local perspective is also needed to evaluate the feasibility and economic impact of these practices. The SB 90-126 Advisory Committee has recommended that a significant level of input be received at the local level prior to adoption of recommended BMPs.

Colorado State University Cooperative Extension has compiled a broad set of BMPs encompassing nutrient, pest, and water management that has been used as a template for local committees. These documents were published in a notebook form in 1995 and are updated and expanded as needed to include additional guidelines.

Cooperative Extension piloted the local BMP development process in the San Luis Valley and in the Front Range area of the South Platte Basin. The local working committees consist of a small group of producers, consultants, and chemical applicators. Both of these groups have produced BMPs for nutrient and irrigation management - the most serious problem in their respective areas. In 1995, the Shavano SCD worked with local Extension agents and producers to develop a set of practices appropriate for the West Slope entitled "Best Management Practices for the Lower Gunnison Basin." During 1996, a fourth local BMP work group was initiated in the lower South Platte Basin. They published their findings in a bulletin entitled "Best Management Practices for the Lower South Platte River Basin." Although most of these work groups have not been active since finishing their local BMP publications, these guides continue to be distributed at the local and state level. The South Platte BMP workgroup in the Front Range area continues to be active and now meets every other year to review current groundwater quality data and discuss research, education, and regulatory issues affecting groundwater in their area.

Building on these efforts, a crop specific BMP, "Best Management Practices for Colorado Corn" was published in 2003. This publication was produced with support from the Colorado Corn Growers and was made available to growers in the spring of 2003. Over 2,000 growers received copies of this manual through a direct mailing by Colorado Corn, distribution through County Extension offices, and handouts at meetings. This BMP covers corn production from hybrid selection to harvest with an emphasis on stewardship and protecting water quality.

Evaluation of BMP Adoption

A mailed crop production survey was conducted during the last week of November, 2001 to measure the progress of our educational efforts related to SB 90-126. This survey was mailed to 3,260 irrigating crop producers. To date, 1,298 (40%) producers have responded with 37% of the responses being usable. The primary objective of this survey was to learn the adoption rate of nutrient, pesticide, and irrigation BMPs among Colorado producers. Results from returned surveys were entered into a database in 2002 and were analyzed and summarized in 2003. These results will be used to focus the groundwater program on the geographical and topical areas that need higher adoption rates to protect water quality. Because we conducted a similar survey in 1997, we can use the 2001 survey to measure progress in our educational efforts since that time. The results of this survey will be published in a technical report and fact sheets in 2004. We will encourage other CSU faculty and County Extension agents, NRCS staff, water and soil conservation districts, and others to use the survey information to focus groundwater protection resources in deficient areas.

Field Demonstration and Research

Field demonstration work in 2003 focused on helping growers improve water management. CSUCE loaned atmometers (ETgages) to county agents, consultants, and individual farmers in Weld, Boulder, Kit Carson, and Yuma counties. ETgages are useful for simple and effective irrigation scheduling. Soil moisture monitoring devices (Water Mark®) were also demonstrated to interested growers in the San Luis Valley. A center pivot nozzle height (above and below canopy) replicated demonstration was conducted in cooperation with the NE Regional Water Specialist, Joel Schneekloth. Nozzle placement can impact water runoff and therefore irrigation uniformity, soil moisture storage, and ultimately, yield. Additionally, we included three in-season tillage treatments: regular cultivation, basin tillage, and inter-row ripping. Irrigation runoff, soil moisture storage, and grain yield were measured. One year of results suggested that placing nozzles at a height just above the canopy reduced runoff, improved soil moisture storage, but did not significantly impact yield as compared to nozzles located within the canopy at 14 inches above the ground.

Additionally, an effort was made to improve the awareness and usability of crop ET information provided by the CoAgMet weather network. Cooperating with field CSUCE faculty and Nolan Doesken in the Colorado Climate Center, we upgraded the usability and output of ET reports from weather stations in the CoAgMet network. Specifically, users now have the ability to choose specific crops, weather stations, and planting dates to customize their reports (see "New ET Reports" link at www.CoAgMet.com). A marketing effort was conducted in Northeastern Colorado to build awareness and adoption of this information for improved irrigation scheduling.

One Weld County farmer conducted a demonstration using irrigation water nitrate crediting where the practice has been studied and demonstrated for five continuous years. The results of these demonstrations are useful in convincing growers to adopt this BMP when using nitrate-enriched ground water.

Education and Communication

Communication is a vital component of the program. Numerous methods are used to provide information to individuals and organizations using agricultural chemicals as well as the general public. We continue to provide written fact sheets and publications with information on the program and distribute them at meetings, conferences, and trade shows.

Also, a display board is being utilized at conferences and trade shows to provide information on the program. Information on groundwater protection is continually being presented to the public through radio shows, mass media, press releases, and presentations at meetings throughout the state. Presentations on how the program works, past and present water quality projects, and plans for future projects with request for local input are made at every opportunity. In 2003, presentations were made at several major meetings and small local groups throughout the state. We consider this type of outreach an important part of the customer service component of the program.

This past year we continue to provide information available over the Internet. Several locations including the CSU Cooperative Extension web site (http://www.ext.colostate.edu), the CSU Cooperative Extension Water Quality web site (http://www.colostate.edu/Depts/SoilCrop/extension/WQ/), and the Agricultural Chemicals and Groundwater Protection Program web site (http://www.ag.state.co.us/dpi/GroundWater/home.html), provide information on BMPs.

We also hired a programmer to create the *Colorado State University Water Quality Interpretation Tool* (http://kiowa.colostate.edu/cwis435/index.cfm): This online water quality interpretation tool is designed to help clientele evaluate the quality of their water for drinking, irrigation or livestock use.

APPENDIX III

2003 Annual Report
Colorado Department of Public Health and Environment

During 2003, the Colorado Department of Public Health and Environment (CDPHE) was involved in a number of SB 90-126 activities. In April of 2003, the vacancy in the Agricultural Chemicals and Groundwater Protection Program at CDPHE was filled by Greg Naugle. Initial activities included an introduction to the goals, activities, and background of the program. During this familiarization period, CDPHE reviewed a number of the previous annual reports, the BMPs that the program has developed, and the historical groundwater analytical data for the prior year's monitoring programs.

CDPHE was also involved in the review and presentation of the groundwater monitoring results from last year, for the Custer County Commissioners. Other groundwater monitoring data that was reviewed by CDPHE included the annual results from the long-term monitoring along the South Platte River Basin in Weld County. Part of the review of the Weld County results also included a preliminary review and assessment of concentration trends in the historical data. CDPHE was also active in the establishment of the monitoring well network along the Arkansas River Basin, and assisted in the planning, outreach, and installation of the monitoring wells.

Finally, CDPHE has been active in acting as a liaison for the program. These activities include communicating the program's purpose and goals to other State and Federal agencies, interested parties, and private citizens. Reports, educational materials, and other correspondence have been distributed in an effort to develop an awareness of the importance of the program to the State's efforts in groundwater protection.

APPENDIX IV

Best Management Practices for Colorado Corn

USGS
science for a changing world

Prepared in cooperation with the
Colorado Department of Agriculture,
Colorado Department of Public Health and Environment, and
Colorado State University Cooperative Extension

Probability of Detecting Atrazine/Desethyl-atrazine and Elevated Concentrations of Nitrate in Ground Water in Colorado

Water-Resources Investigations Report 02–4269

U.S. Department of the Interior
U.S. Geological Survey

Homeowner's GUIDE To Protecting Water Quality and the Environment

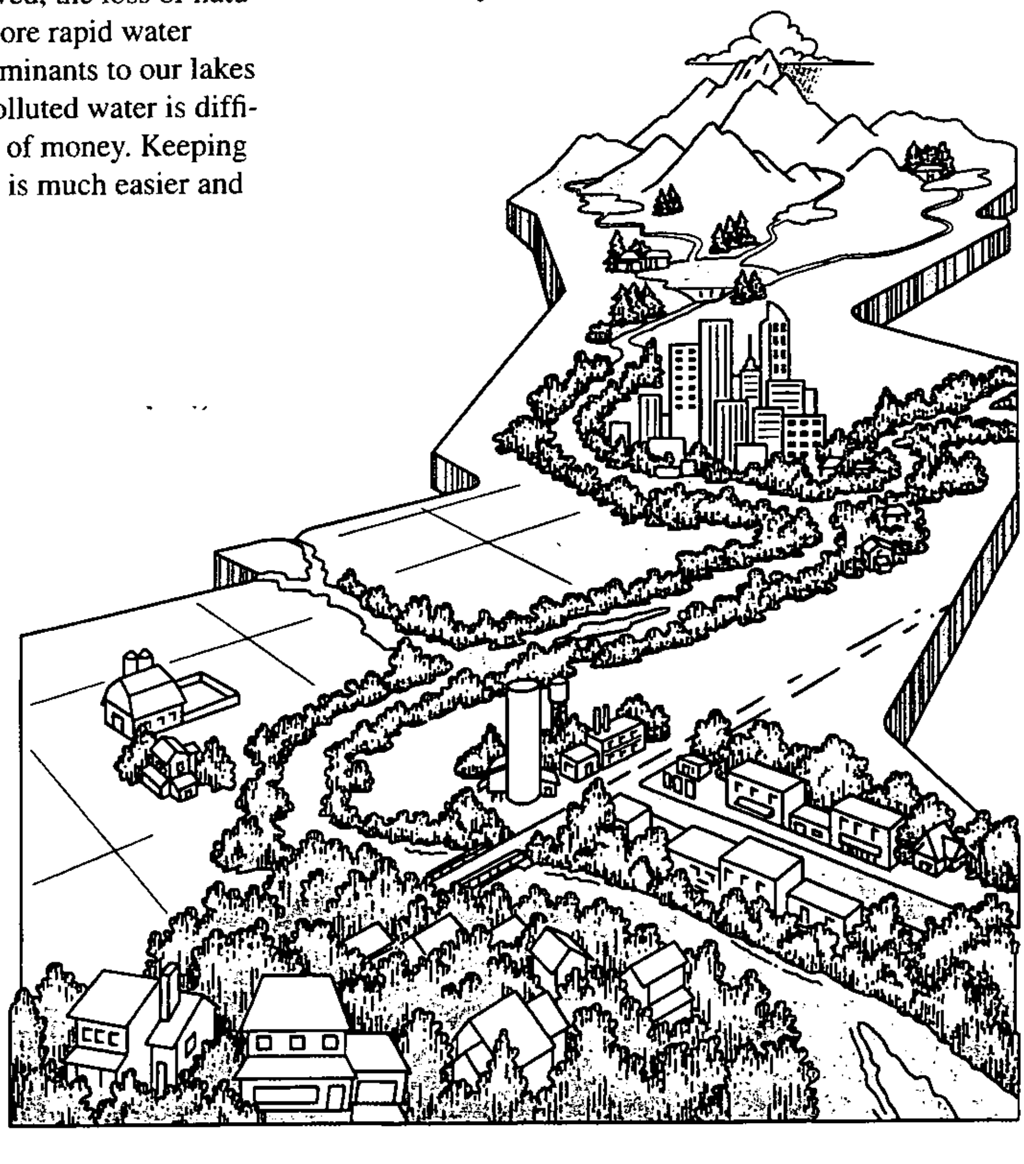
XCM-223

It's a fact of modern life - many of our activities have altered the natural cycles of water movement and purification that give us clean water. And while our individual homes may contribute only small amounts of pollutants, they add up to bigger problems downstream.

The watershed in which you live probably consists of houses, businesses and undeveloped land. The water from this area drains to a creek or river. As cities develop and streets are paved, the loss of natural vegetation results in much more rapid water runoff. This runoff carries contaminants to our lakes and streams. Cleaning up this polluted water is difficult and can cost taxpayers a lot of money. Keeping our water clean in the first place is much easier and cheaper.

In the Home

The typical home contains an amazing assortment of cleaning products, paints, solvents, oils, fertilizers and pest control products. If used according to their labels, they can make our lives easier. But many of these products fall within the Environmental Protection Agency's definition of hazardous substances because they can catch fire, explode, corrode or because they are toxic.



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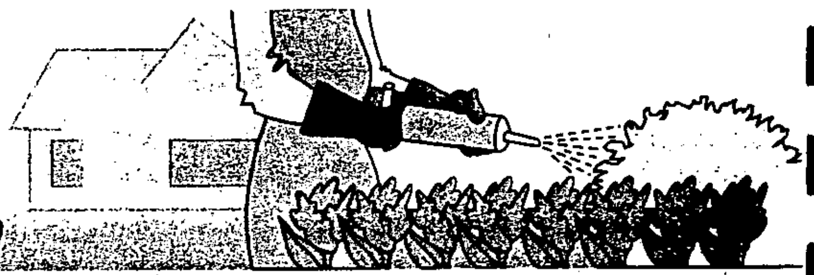
Putting Knowledge to Work

Homeowner's GUIDE



To Pesticide Use Around the Home and Garden

XCM-220

Pesticides can serve a useful purpose around the home and garden by reducing some of the problems we face from pests. But they can harm our drinking water supplies if handled improperly.

Pesticides include insect killers (insecticides), weed killers (herbicides), and fungus killers (fungicides). The ingredients that make these chemicals toxic to pests also can be harmful to people and animals, and in some cases, they can also contaminate water supplies.

This can happen even when pesticides are used according to the label. Water contamination is costly to remedy, and homeowners who use pesticides need to follow some common sense guidelines to avoid these unintended consequences.

Before You Buy a Pesticide

Pest-free homes and gardens are expensive, impractical, and environmentally unsound. The urge for a chemical "quick fix" for every problem around the home should be re-evaluated. Instead, maintaining weeds or garden insects at non-damaging levels is a more realistic goal. Allowing low levels of pests to survive will actually help maintain a population of natural enemies.

There are a number of strategies homeowners can use to manage pests without chemicals. Evaluate all your options such as non-toxic sprays, biological controls, changes in cultural practices, or even doing nothing before you purchase a chemical. In some

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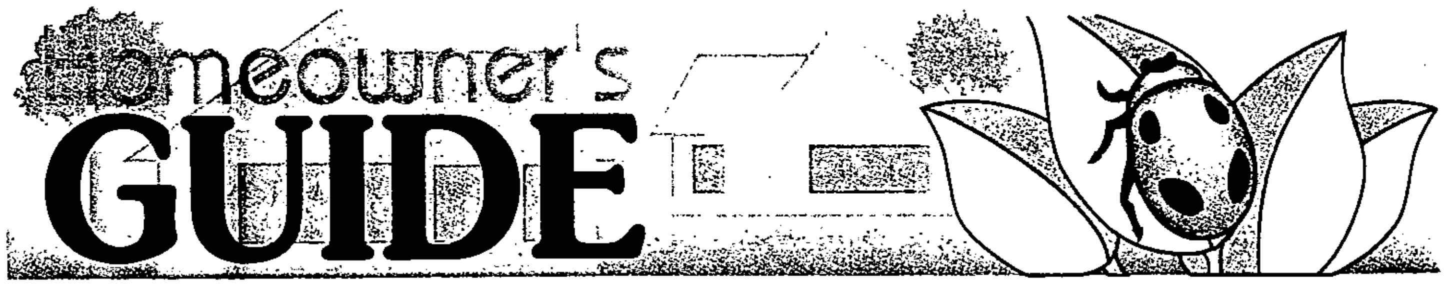

Alternative Pest Management for the Lawn and Garden

XCM-221

A pest-free lawn and garden may sound ideal, but is it really? Maintaining the perfect urban landscape often results in a reliance on pesticides that can lead to environmental and human health problems.

Many homeowners are turning to pesticide alternatives as they re-evaluate the consequences of their not-so-ideal landscaping.

Fortunately, there are many biological processes that work to keep pests in a natural balance. The 'ideal' garden is one with vigorous plants and protected natural enemies of certain annoying pests. The conventional approach—of applying pesticides routinely, or at the first sign of any pest—is replaced with a lower input emphasis on nature at its best.

An alternative approach is not the answer to all problems every time. But when it works, it is an ideal way to address pest problems while helping protect our water supplies.

The principles of this alternative approach include:

- Learning more about plants and their pests.
- Selecting landscape and garden plant varieties that are resistant to pests.
- Rotating annual garden plants to reduce the buildup of pests.
- Inspecting plants frequently for the presence both of pests and beneficial organisms.
- Determining if control measures are really necessary before taking action.
- Selecting methods that are least disruptive to natural controls and least hazardous to the environment.

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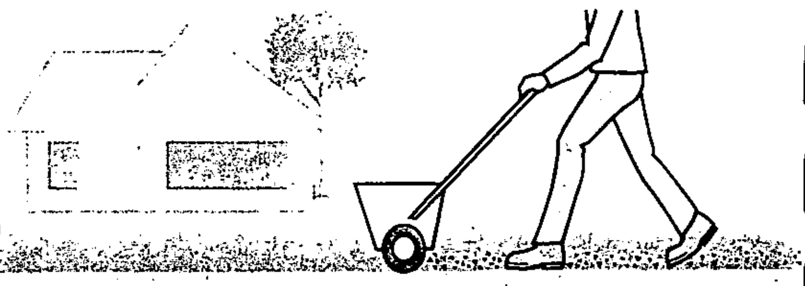
Putting Knowledge to Work

Homeowner's GUIDE



To Fertilizing Your Lawn and Garden

XCM-222

We all want a home landscape that is attractive – but did you know that some of our common landscape management practices can cause pollution? The improper use of lawn fertilizers has the potential to harm our water supplies.

Have you ever noticed a pond that was overgrown with weeds or algae? Chances are, it received an excess of nutrients – perhaps from urban runoff from lawns or gardens. Drinking water supplies may also become contaminated by nutrients from fertilizer. In extreme cases it can even cause health problems.

Your yard can have a positive effect on water quality by slowing down and filtering runoff water, or it can contribute to water quality problems. It all depends on how you manage water, chemicals, and the landscape around your home. Fertilizer carelessly applied on one lawn may seem insignificant. On hundreds or even thousands of lawns it can add up to polluted streams, lakes, and even groundwater.

What Can You Do to Protect Water Quality?

- Fertilize your lawn and garden properly.
- Water wisely.
- Use low maintenance landscaping.
- Maintain a healthy lawn.

Fertilizing Your Lawn for Healthy Plants and Clean Water

An effective lawn fertilization program actually starts in early fall, not in the spring. Spring applications alone may promote excessive top growth, leaving shallow root systems that poorly sustain lawns during hot dry spells or harsh winters. Fall fertilizer applications on established grass promotes healthy root systems and hardy lawns.

One way to know how much fertilizer to apply is to take a soil test. If an analysis is not feasible, Table 1 shows the proper timing and amounts for various lawn types common in Colorado. The table assumes that all lawn clippings are left on the lawn to be recycled naturally. Keep in mind that over-fertilizing and other poor cultural practices are the primary reasons for thatch buildup— not grass clippings.

Selecting a Fertilizer

The label on all fertilizer bags contains three numbers that describe the amount of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). For example, a 40 pound bag of 20-10-5 fertilizer contains 20 percent (8 pounds) nitrogen, 10 percent (4 pounds) phosphate, and 5 percent (2 pounds) potash.

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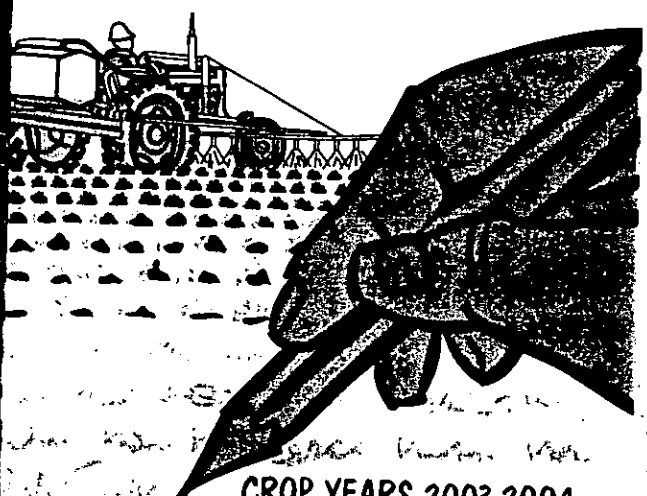
Putting Knowledge to Work

Pesticide Record Book
for Private Applicators



CROP YEARS 2003-2004

APPENDIX V

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION ACT ADVISORY COMMITTEE
(Revised 2/03)

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