

**SURVEY FOR BENTAZON IN WELL WATER
OF 15 CALIFORNIA COUNTIES,
DECEMBER 1988 - MAY 1989**



OCTOBER 1989

Environmental Hazards Assessment Program

**STATE OF CALIFORNIA
Department of Food and Agriculture
Division of Pest Management, Environmental Protection and Worker Safety
Environmental Monitoring and Pest Management Branch
1220 N Street, Sacramento, California 95814**

EH 89-10

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By

J.A. Sitts

October, 1989

ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

ABSTRACT

In August of 1981, the Central Valley Regional Water Quality Control Board detected the herbicide bentazon (Basagran®) in a water well located at a pesticide applicator washdown site in Glenn County. This detection was reported to the California Department of Food and Agriculture (CDFA) in 1986 as required by the Pesticide Contamination Prevention Act of 1985. As part of its policy to investigate such historical data as time and resources permit, the CDFA sampled to verify the presence of bentazon residues in well water and determine whether they were due to legal agricultural use of bentazon. After it was determined that residues resulted from agricultural use, expanded monitoring was conducted to determine the extent of contamination.

Samples were collected from 190 wells between December of 1988 and April of 1989. Wells were sampled in 14 rice growing counties with reported bentazon use (Butte, Colusa, Glenn, Kern, Madera, Merced, Placer, Sacramento, San Joaquin, Stanislaus, Sutter, Tehama, Yolo, and Yuba) and in Santa Barbara County where bentazon was used only on non-rice crops.

Samples from all of the wells were analyzed for bentazon. Sixty-three wells in 10 rice growing counties were confirmed positive, with concentrations ranging from 0.10 to 13.70 parts per billion (ppb). The minimum detection limit (MDL) was 0.50 ppb for the first six wells sampled, and 0.10 ppb for the 184 subsequent wells. No concentrations exceeded the maximum contaminant level for drinking water of 18 ppb set by the California Department of Health Services.

Samples from 19 wells in two counties were also analyzed for the rice herbicides molinate (MDL = 0.20 ppb) and thiobencarb (MDL = 0.20 ppb). Samples from 34 wells in three counties were analyzed for MCPA (MDL = 0.10 ppb), another rice herbicide. None of the samples had detectable levels of these pesticides.

Samples from 90 wells in 12 counties were analyzed for the herbicides: atrazine, simazine, prometon, and bromacil (MDL's = 0.10 ppb). Three of these wells were also analyzed for diuron (MDL = 0.10 ppb). One well in Tehama County was confirmed positive for atrazine, simazine, prometon and diuron.

Sampling was completed before the 1989 bentazon applications began. Thus, bentazon apparently can reach ground water and remain there for at least several months after its use. The high number and widespread occurrence of wells containing bentazon suggest that the legal agricultural use of bentazon in California has allowed the herbicide to reach ground water. The absence of other rice herbicides in wells positive for bentazon suggests that the physical or chemical properties of bentazon allow it to move to ground water more readily than the other herbicides. More study is needed to characterize and prevent off-target movement of bentazon into ground water.

ACKNOWLEDGMENTS

Thanks for a job well done to all CDFA personnel involved in this study, including: the EHAP field group for unsurpassed teamwork during sample collection; Nancy Miller (EHAP Laboratory Liaison) for her assistance and patience; Don Weaver, Randy Segawa, and Joan Fleck for their valuable contributions to study design and project administration; and to the CDFA Laboratory Services Branch, Environmental Monitoring, for prompt and efficient sample analysis.

DISCLAIMER

The mention of commercial products, their source or use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such product.

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INTRODUCTION

Bentazon [3-isopropyl-(1H)-benzo-2,1,3-thiadiazin-4-one 2,2-dioxide] is a post-emergent contact herbicide used to control actively growing sedges and broadleaf weeds. The BASF Wyandotte Corporation (Parsippany, NJ) markets bentazon under the trade name Basagran®. The active ingredient in Basagran® is the sodium salt of bentazon. The formulation is a soluble concentrate which is diluted and applied by ground or aerial spray at a rate of 0.84 - 1.12 kg/ha (0.75-1.00 lb/ac). The amount applied in each growing season cannot exceed the maximum of 2.24 kg/ha (usually two applications). Bentazon is often used in mixed formulations with other herbicides, is quite soluble in water (230 g/100g), and is resistant to hydrolysis (Kishlushko, 1982).

In California, most bentazon use is on rice (Oryza sativa L.) (Table 1). The remainder is divided between corn (Zea mays L.), beans (Phaseolus vulgaris L.), peas (Pisum sativum L.), turf (various grasses - family *Poaceae*), and landscape applications.

In 1987 (the most recent year with available use data), bentazon was applied in twenty-nine counties throughout California (Table 2). The majority of rice in California is grown in the Sacramento Valley, and bentazon use is highest in that region. Bentazon is usually applied to rice 30 to 40 days after planting in the spring and early summer.

In August of 1981, the Central Valley Regional Water Quality Control Board (CVRWQCB) conducted a point source investigation in Glenn County. A single water well was found positive for bentazon. The well was located at a pesticide applicator washdown site and was near a leachfield into which rinsewater was discharged. The maximum concentration of 20 parts per billion (ppb) exceeded the maximum contaminant level for drinking water of 18 ppb set by the California Department of Health Services. As required by the Pesticide Contamination Prevention Act of 1985 (AB2021), the CVRWQCB notified the Environmental Hazards Assessment Program (EHAP) of the results in September of 1986.

Following the inclusion of this information in the 1988 Well Inventory Report (Cardozo, 1988), this study was undertaken during the winter of 1988 and the spring of 1989 to determine if wells other than the originally reported positive well contained bentazon. Sampling for bentazon in well water was conducted in five distinct phases. As each phase was completed the results of that phase determined whether another phase was necessary, and what form the next phase would take.

The specific objectives of each phase follow: **Phase I (Four-Section Survey)** - to confirm the presence of bentazon in the positive well reported by the CVRWQCB, and to determine if bentazon could be found in a second well located within approximately 1.61 km (1 mile), **Phase II (Area Surrounding the Four-Section Survey)** - to determine if bentazon could be found in well water in the area surrounding the area examined in phase I and to help determine if the bentazon residues were due to legal agricultural use (as defined in the Pesticide Contamination

Prevention Act), **Phase III (Sampling to the South and West)** - to determine if bentazon could be found in well water further south or west of the area sampled in phase II and to evaluate whether a regional problem existed, **Phase IV (Sampling 12 Rice Growing Counties)** - to determine if bentazon could be found in well water in other rice-growing counties with a record of bentazon use, and **Phase V (Sampling 1 Non-rice Growing County)** - to determine if bentazon could be found in well water in a county with all bentazon use on crops other than rice.

Table 1. Bentazon use in California from 1985 through 1988.

Year	Total Bentazon Use ^a (kg)	Amount Used on Rice (kg)	Total area Treated (ha)	Area of Rice Treated (ha)
1985	93,482	----- ^b	85,178	-----
1986	97,485	96,914	82,579	82,053
1987	75,307	74,375	56,091	55,214
1988 ^c	-----	122,472	-----	103,199

^aAll use and area data are based on CDFA Pesticide Use Reports.

^b----- = Data unavailable.

^cBentazon use data for 1988 are estimates based on Notices of Application filed with California County Agricultural Commissioners by bentazon applicators.

Table 2. California counties ranked by amount of 1987 Bentazon use and the crops which bentazon was applied to in each county.

Rank	County	Active Ingredient Applied ^a (kg)	Crops ^b
1	Butte	17,753	R,B
2	Yuba	16,476	R
3	Sutter	13,144	R,B
4	Glenn	8,955	R,B,C
5	Colusa	5,036	R
6	Placer	4,186	R,L
7	Sacramento	3,849	R,L,C
8	Yolo	1,262	R,T,C
9	San Joaquin	1,115	R,B,L
10	Fresno	1,090	R,P
11	Stanislaus	1,085	R,L
12	Merced	539	R
13	Kern	213	R
14	Madera	166	R
15	Tehama	131	R,B
16	Santa Barbara	119	B,C
17	Monterey	58	B,C,P
18	Contra Costa	48	W,L
19	San Benito	27	B
20	Santa Clara	16	P,B,L
21	San Luis Obispo	12	P,B
22	San Mateo	9	P
23	Santa Cruz	4	B
24	Los Angeles	4	L
25	Alameda	4	L
26	Sonoma	2	L
27	San Diego	<1	L
28	Marin	<1	L
29	Riverside	<1	T

^aUse Data are from 1987 CDFA Pesticide Use Reports.

^bBentazon applied to the listed crops: Rice (R), Beans (B), Corn (C), Landscape (L), Turf (T), Peas (P), and Rights of Way (W).

MATERIALS AND METHODS

Well Selection

For each phase, wells were sampled within selected sections. The selection criteria were based on the proximity to known positive wells or the record of bentazon use within a section. A section is a 1.61 km x 1.61 km (1 x 1 mile) area used in the township, range, section system on maps produced by the United States Department of the Interior, Geological Survey.

If a section did not contain any wells, or permission to sample could not be obtained, then an adjacent or nearby section was substituted for the selected section.

Within these sections domestic wells were sampled whenever possible; domestic wells are more likely to be sealed than irrigation wells, and are less likely to have a pump which leaks lubricating oil into the casing. Wells with Water Well Drillers Reports (well logs) were sampled when possible, but all of the areas sampled had few usable logs on file with the California Department of Water Resources. Thirty-four of the 190 wells sampled had well logs on file.

Sample Collection

The pumps on most wells (185) were run for at least 10 minutes prior to sampling to purge the casing of standing water. The remaining five

wells were run for as long as possible, and the length of time was noted on the chain of custody record, a document which contained all sampling information. When possible, samples were taken from a sampling port (usually a faucet, Schrader valve, discharge pipe, or pressure relief valve) located prior to the storage tank (120 wells). It was necessary to sample some wells after a storage tank (70 wells).

At each well site, six 1-liter amber glass bottles were filled and sealed with Teflon®-lined lids. Four bottles were filled with well water: the primary sample, the replicate sample, and two backup samples. For quality control, two bottles, the field blanks, were filled with distilled water.

All samples were immediately cooled with wet ice and stored at 4°C until analyzed. Each sample had a chain of custody record which contained all pertinent information. Each well and the surrounding site was described, mapped, and photographed.

Site Selection

Phase I - Four-Section Survey

In December of 1988, phase I was conducted in Glenn County. The original positive well reported by the CVRWQCB was resampled, and five other wells, located within the same section and two of the nearest adjacent sections, were also sampled (Figure 1). An attempt was made to select wells close to and surrounding the original positive.

Phase II - Area Surrounding the Four-Section Survey

Because additional positives were found in phase I, phase II was conducted in Glenn County in January of 1989. Two wells were to be sampled in each of the 12 sections that bordered the original four-section area (Figure 2). A total of 24 wells were sampled in 15 sections (Figure 3).

Phase III - Sampling to the South and West

Phase III was undertaken in February of 1989 after more positive wells were detected in phase II. Because most of the positive wells were clustered toward the south and west, the sampling was extended in those directions to determine if bentazon contamination extended further. Two areas were selected for sampling. The first area was just west of the phase II sections and was located in Glenn County. The other area was just south of the phase II sections and was located in both Glenn and Colusa counties. Each area was 4 sections by 6 sections. One well was to be sampled in each of the 48 sections (Figure 4). A total of 48 wells were sampled in 41 sections (Figure 5).

These two areas were also selected because they had differences in the amount of bentazon used in 1987. In the area to the west 1485 kg of bentazon had been applied, while in the area to the south only 357 kg had been used.

Initially it was thought that the soil in the two areas also differed significantly. However, a closer comparison of the soil textures (based

on the textural family for the soil series corresponding to the mapping units found in each section) revealed little difference between the two areas. In each section the dominant texture for approximately the 25-102 cm depth (10 to 40 inches) was determined. Of the 24 sections to the west, 16 were clay, seven were clay and loam, and one was loam. Of the 24 sections to the south, 19 were clay, two were clay and loam, and three were loam.

Phase IV - Sampling 12 Rice Growing Counties

After phase III results showed additional confirmed positive wells in large areas of two rice growing counties, phase IV was designed to survey the 13 remaining rice growing counties with a record of bentazon use. A maximum of ten wells were to be sampled in each county. One or two wells were to be sampled in each of the sections with the highest bentazon use in 1987. In February of 1989, a total of 100 wells were sampled in the following 12 counties: Butte (10 wells), Kern (2 wells), Madera (3 wells), Merced (7 wells), Placer (10 wells), Sacramento (10 wells), San Joaquin (10 wells), Stanislaus (10 wells), Sutter (10 wells), Tehama (8 wells), Yolo (10 wells), and Yuba (10 wells). In Fresno County, no samples were obtained due to a lack of wells in the areas of bentazon use.

Phase V - Sampling One Non-rice Growing County

Additional positive wells found in phase IV confirmed the presence of bentazon in wells over a large area in counties where bentazon was used on rice. There are also several counties in California where bentazon is used exclusively on non-rice crops; their cultural and irrigation practices are different than those of rice. Santa Barbara County was selected for sampling because it had the highest non-rice bentazon use in 1987 (89% on beans and 11% on corn). In March of 1989, one well was sampled in each of the ten highest use sections.

Additional Sampling in Glenn County

Two wells, originally sampled in November of 1988 for other monitoring, had backup samples analyzed for bentazon in February of 1989. Because two sample bottles are required for sample confirmation, and only one bottle per well was available for analysis, the wells were resampled in April of 1989.

One positive well in Glenn County, originally sampled in January of 1989 (phase II), was resampled in April of 1989 to obtain additional information.

Additional Herbicides

Backup samples from 15 wells in Glenn County, 10 in Sutter County, and 10 in Yuba County were analyzed for MCPA (4-chloro-2-methyl

phenoxyacetic acid), another post-emergent herbicide used on rice. CDFA Pesticide Use Reports were not available for MCPA at the time this paper went to print.

Nineteen backup samples from wells positive for bentazon in Glenn (12 wells) and Colusa (7 wells) counties were analyzed for molinate [S-ethyl hexahydro-1 H-azepine-1-carbothioate (Ordram®)], and thiobencarb [S-(4-chlorophenyl) methyl diethyl carbamothioate (Bolero®)], two herbicides used extensively on rice in those counties (Table 3).

Samples from 90 wells in 12 counties were screened for the following four herbicides: atrazine, simazine, prometon, and bromacil. This pesticide screen is routinely used on well water samples taken for other monitoring which is conducted in accordance with the Pesticide Contamination Prevention Act. Atrazine (2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine), bromacil [5-bromo-3-sec-butyl-6-methyluracil], and simazine [2-chloro-4,6-bis(ethylamino)-1,3,5-triazine] are used as selective herbicides on crop areas, and non-selective herbicides on non-crop areas. Prometon [2,4-bis(isopropylamino)-6-methoxy-1,3,5-triazine] is used as a non-selective herbicide on non-crop areas. Three wells (one each in Tehama, Yolo, and Yuba counties) were also analyzed for diuron [3-(3,4-dichlorophenyl)-1,1-dimethylurea], a pre-emergent herbicide. These herbicides are not used on rice, but two have non-rice uses in common with bentazon (atrazine on corn, and simazine on corn and beans).

The exact amounts of atrazine, simazine, diuron, prometon, and bromacil applied in any county or area cannot be determined. Their use has not been restricted, so CDFA Pesticide Use Reports are not required for all applications.

Bentazon has been used in mixed formulations with either atrazine or MCPA.

Chemical Analysis

Bentazon

The samples were rinsed with methylene chloride (MeCl_2) under basic conditions ($\text{pH} > 10$) to remove interferences. They were then acidified ($\text{pH} < 2$) and extracted with MeCl_2 . The extracts were concentrated and derivatized with diazomethane. A final volume of 1 mL was obtained and the extracts were analyzed using a Varian® Model 6000 gas chromatograph equipped with a thermionic specific detector. A Finnigan® Model 5100 Mass Spectrometer in selected ion mode was used for qualitative confirmation. A detailed description of analytical methods is presented in Appendix I.

MCPA

The samples were extracted with MeCl_2 under acidic conditions ($\text{pH} < 2$), concentrated, and derivatized with diazomethane. The extracts had a final volume of 2 mL and were analyzed using a Varian® gas chromatograph (Model 3700 or Model 6000) equipped with an electrolytic conductivity detector (in halogen mode). A detailed description of analytical methods is presented in Appendix I.

Thiobencarb and Molinate

The samples were extracted with MeCl_2 under basic conditions ($\text{pH} > 10$). The solvent was exchanged and reduced to a final volume of 1 mL. The

extracts were analyzed on a Varian® gas chromatograph (Model 3400 or Model 3700) equipped with a thermionic specific detector. A detailed description of analytical methods is presented in Appendix I.

Screen for Atrazine, Bromacil, Prometon, and Simazine

The samples were extracted with MeCl_2 . The solvent was exchanged and a final volume of 3 mL was obtained. The extracts were filtered and analyzed on a Varian® Model 3700 gas chromatograph equipped with a thermionic specific detector. A detailed description of analytical methods is presented in Appendix I.

Diuron

Extract preparation was identical to the procedures used for atrazine, simazine, prometon, and bromacil. The extracts were then analyzed on a Perkin Elmer® Series 4 high pressure liquid chromatograph equipped with a variable wavelength ultraviolet detector. A detailed description of analytical methods is presented in Appendix I.

Quality Control

Bentazon

As part of the method development and validation process, 10 blank matrix spike samples (deionized water and a known quantity of bentazon) were prepared, extracted and analyzed.

For continuing quality control, one blank matrix sample (deionized water) and two blank matrix spike samples were extracted and analyzed in each extraction set.

Periodically, blind spikes (blank matrix spike samples disguised as normal samples) were submitted to the laboratories. Seven blind spikes were submitted to the CDFA laboratory, and six were submitted to Enseco.

The presence of bentazon was confirmed in each positive well, as required by Assembly Bill 2021, by the following two types of verification. The first, sample verification, consisted of finding bentazon in at least two discrete samples from each positive well. The second, analytical verification, consisted of finding bentazon in a sample from the positive well by two different methods (e.g. gas chromatography and mass spectrometry) and/or by two different laboratories (e.g. CDFA and Enseco).

A comparison of results from pairs of samples taken from the same well was used as an indicator of the precision obtained within each laboratory and between laboratories. Four pairs were analyzed within CDFA. Fifteen pairs were analyzed within Enseco. Fifty-three pairs had one sample analyzed by Enseco and the other analyzed by CDFA.

At least one field blank corresponding to each well was analyzed for bentazon.

Additional Herbicides

For all additional herbicides, one blank matrix sample and one blank matrix spike sample were analyzed in each extraction set. All positive wells were confirmed through sample and analytical verification.

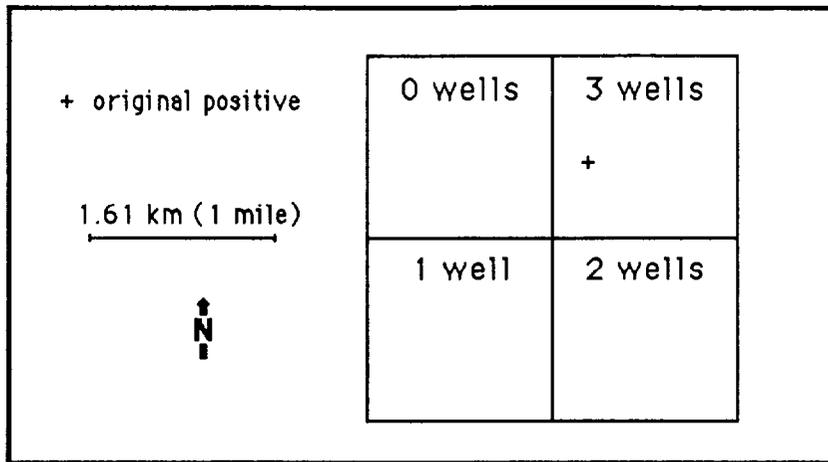


Figure 1. The distribution of the six wells sampled for bentazon during phase I, December 1988, in four sections of Glenn County.

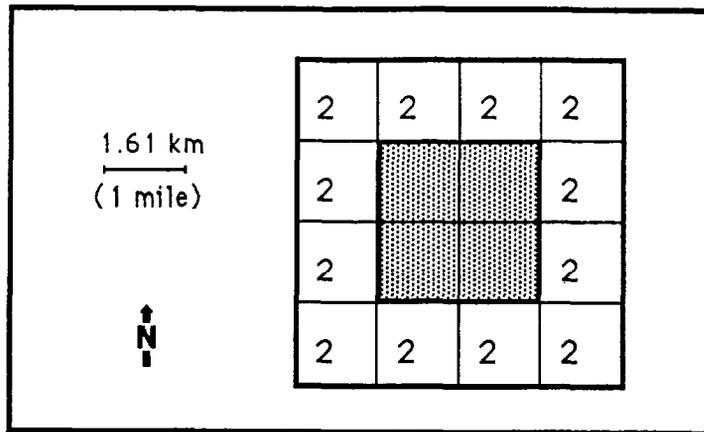


Figure 2. The proposed distribution of the 24 wells to be sampled for bentazon during phase II, in the 12 sections of Glenn County that are adjacent to the four-section area of phase I (shaded area).

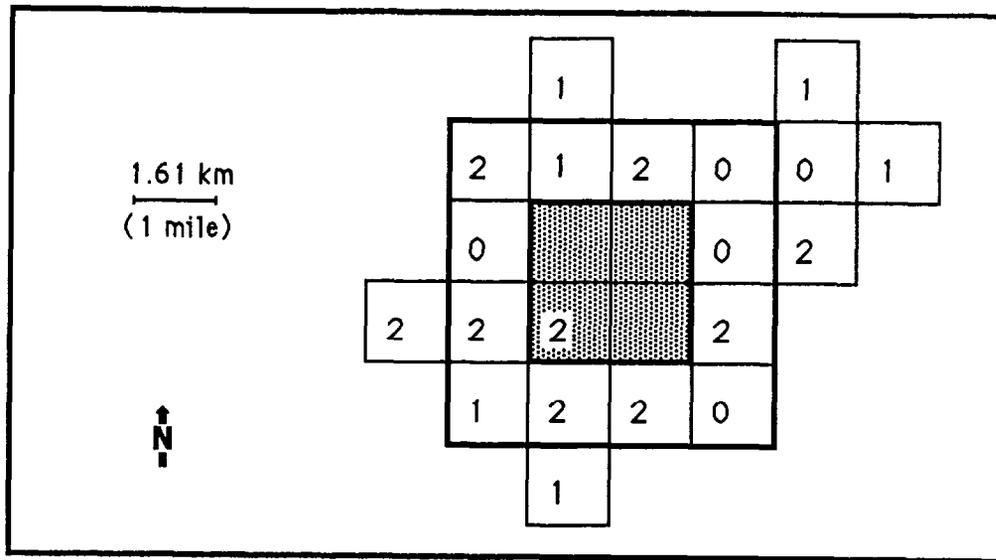


Figure 3. The distribution of the 24 wells sampled for bentazon during phase II, January 1989, in 15 sections of Glenn County. The shaded area represents the four-section area of phase I.

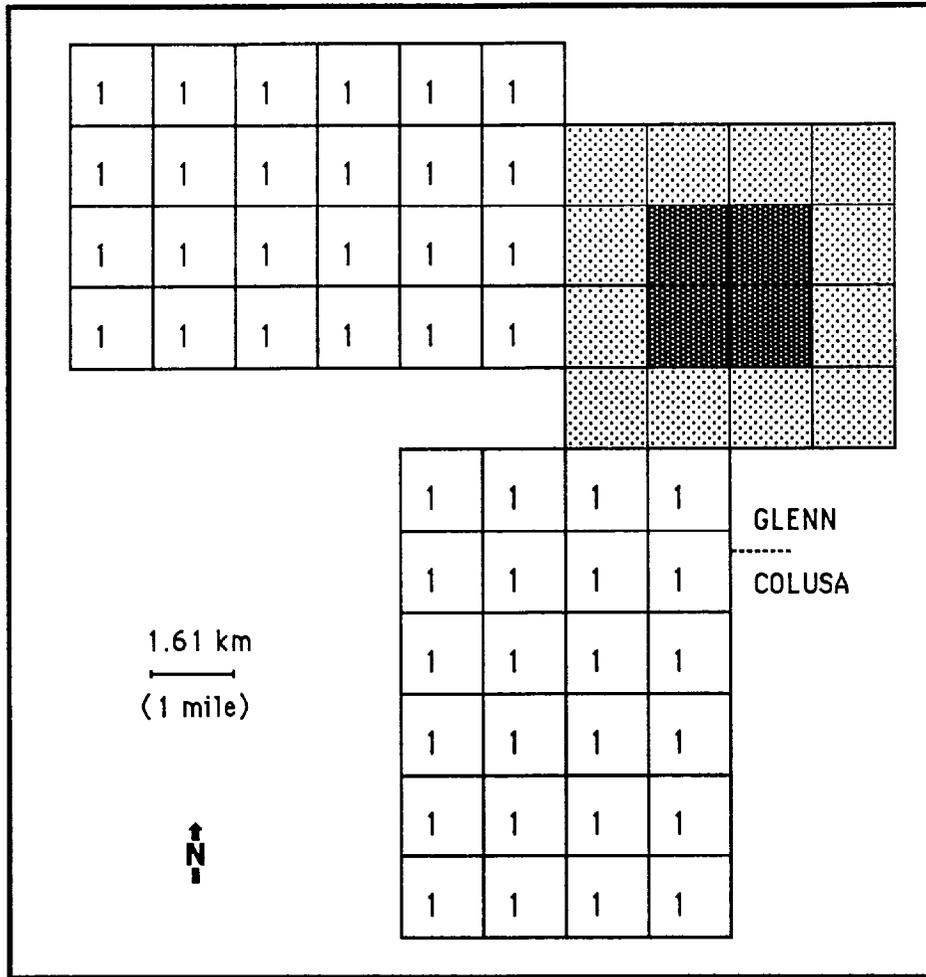


Figure 4. The proposed distribution of the 48 wells to be sampled for bentazon during phase III, in the 48 selected sections of Glenn and Colusa counties. The phase I area is darkly shaded and the phase II area is lightly shaded.

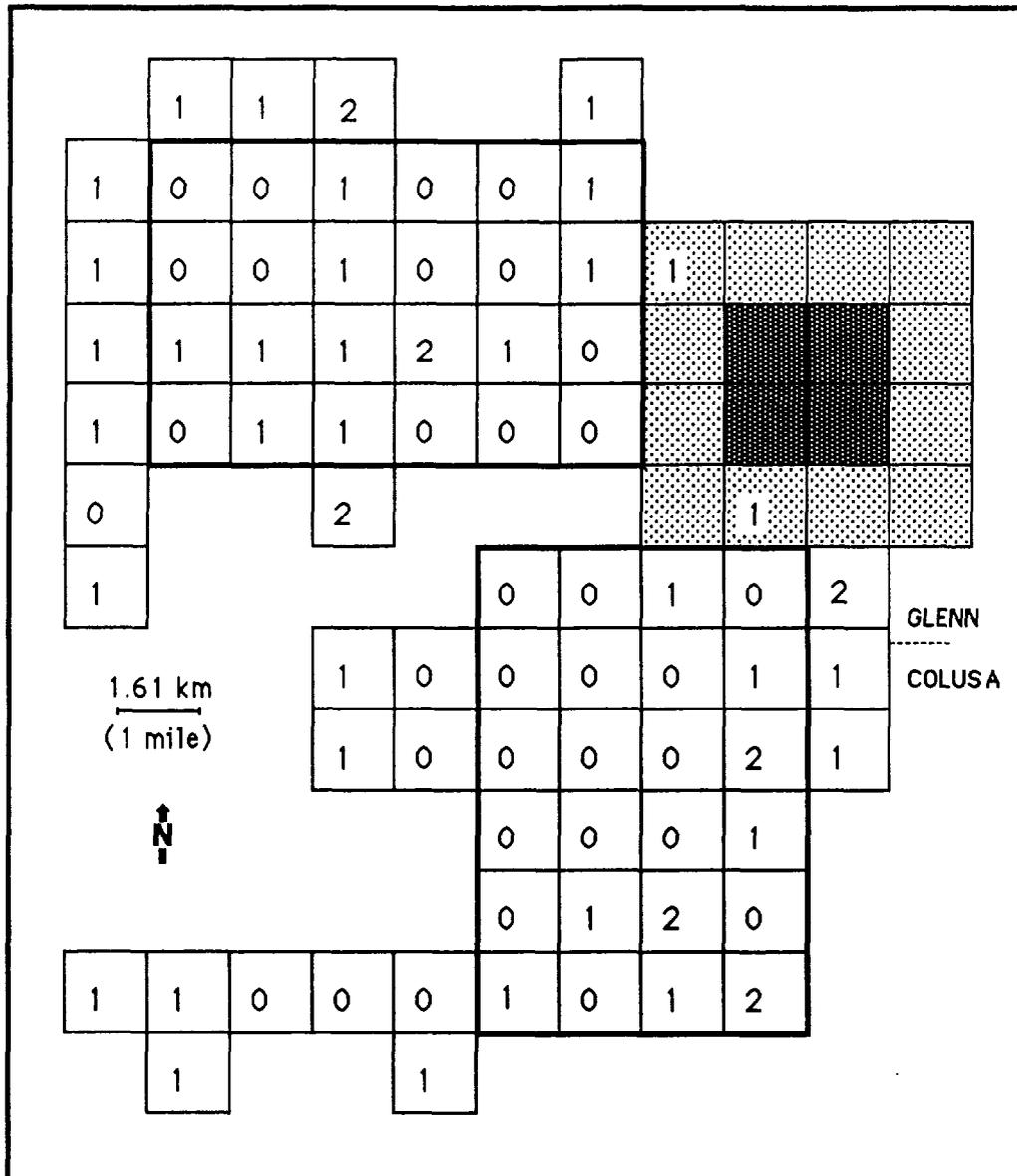


Figure 5. The distribution of the 48 wells sampled for bentazon during phase III, February 1989, in 41 sections of Glenn and Colusa counties. The phase I area is darkly shaded, the phase II area is lightly shaded, and the proposed sampling area is outlined by a solid, dark line.

Table 3. A comparison of bentazon use with molinate and thiobencarb use in Glenn and Colusa counties, for the 1987 growing season.

County	Bentazon Area Treated ^a (ha)	Molinate Area Treated ^b (ha)	Thiobencarb Area Treated ^c (ha)
Glenn	7,347	25,830	1,693
Colusa	4,342	36,095	9,473

^aInformation on 1987 bentazon use is from CDFA Pesticide Use Reports.

^bInformation on 1987 molinate use is an estimate based on Notices of Application filed with California County Agricultural Commissioners by molinate applicators.

^cInformation on 1987 thiobencarb use is an estimate based on Notices of Application filed with California County Agricultural Commissioners by thiobencarb applicators.

RESULTS AND DISCUSSION

Bentazon Results

The concentrations reported in the text are the highest value obtained from each well; concentrations for all analyzed samples are presented in the tables. For maps showing well locations in each county sampled, see Appendix III.

Phase I

The primary laboratory for phase I (Enseco) achieved a minimum detection limit (MDL) of 0.5 ppb. Of the six wells sampled, four had detectable levels of bentazon (Table 4). The highest concentration of bentazon, 13.7 ppb, was found in the original positive well in Glenn County. The three other positive wells had bentazon concentrations which ranged from 1.23 to 4.30 ppb. Positives were found to the north, east, and south of the original detection (Figure 6); one positive was over 1500 m away from the original well.

Phase II

The laboratories (CDFA and Enseco) achieved an MDL of 0.1 ppb. Of the 24 sampled wells, nine were confirmed positive for bentazon (Table 5). Of the 15 sampled sections, seven had at least one positive well. Concentrations ranged from 0.10 to 13.2 ppb. Positives were found to

the north, west and south of the original positive well and up to 4800 m away from the original detection (Figure 7).

Phase III

The analyzing laboratories achieved an MDL of 0.1 ppb. Phase III yielded 20 confirmed positives (in 19 sections) out of a total of 48 wells (in 41 sections) sampled. Of the 19 wells sampled in 16 sections of Colusa County, seven wells in seven sections were confirmed positive. The maximum concentration was 2.81 ppb (Table 6). Of the 29 wells sampled in 25 sections of Glenn County, 13 wells in 11 sections were confirmed positive. The maximum concentration was 4.24 ppb (Table 7). There were positives in both sampling grids, 11 out of 25 wells (9 positive sections out of 22 sections sampled) to the west and 9 out of 23 wells (9 positive sections out of 19 sections sampled) to the south (Figure 8). The total 1987 bentazon use in the sections sampled was 1206 kg in the grid to the west, and 164 kg in the grid to the south. Positives were found over 12 km from the original well in both the south and west directions.

Phase IV

The MDL for all wells sampled in phase IV was 0.1 ppb. Of the 100 wells sampled (in 12 counties), 28 wells (in 8 counties) were confirmed positive. The concentrations of positive samples ranged from 0.10 to 10.20 ppb. Four of the counties had no confirmed positives: Kern County with two wells sampled (Table 8), Madera County with three wells sampled

(Table 9), San Joaquin County with 10 wells sampled (Table 10), and Tehama County with eight wells sampled (Table 11). Three counties had one confirmed positive each: Merced County with seven wells sampled (Table 12), Placer County with 10 wells sampled (Table 13), and Sacramento County with 10 wells sampled (Table 14). Stanislaus County with 10 wells sampled (Table 15) and Yolo County with 10 wells sampled (Table 16) had three confirmed positives each. Yuba County with 10 wells sampled (Table 17) had four confirmed positives. Sutter County with 10 wells sampled (Table 18) had seven confirmed positives. Butte County with 10 wells sampled (Table 19) had eight confirmed positives.

Phase V

The MDL was 0.10 ppb for all phase V wells. Of the 10 wells sampled in 10 Santa Barbara County sections none had detectable levels of bentazon (Table 20).

Additional Wells

Two wells in Glenn County were sampled for bentazon, but were not part of sampling for phases I through III. They were originally sampled during unrelated monitoring in November of 1988 and each had a backup sample analyzed for bentazon. The wells were resampled to obtain sample and analytical verification in April of 1989. Both were confirmed positive for bentazon (Table 21). The concentrations found were 0.47 and 2.10 ppb.

A well in Glenn County which was found positive for bentazon during phase II in January of 1989, was also positive when it was resampled in April of 1989. Bentazon concentrations were 13.20 ppb in January, and 6.70 ppb in April (included in Table 5).

Results of Additional Herbicide Analyses

MCPA

None of the samples from 35 wells in three counties had detectable levels of MCPA (Table 22). The detection limit for MCPA was 0.10 ppb. The EHAP had not conducted any prior studies looking specifically for MCPA; however, in 1986, 33 wells in Glenn county were sampled for chemicals used on rice including: ethyl and methyl parathion, carbaryl, and carbofuran (Segawa, et al, 1986). None of the wells had detectable levels of any of these pesticides.

Molinate and Thiobencarb

None of the samples from 19 wells in Glenn and Colusa counties had detectable levels of molinate or thiobencarb (Table 23). The detection limit for both herbicides was 0.20 ppb. A study conducted by the EHAP in 1985 also found no detectable levels (MDL = 0.1 ppb) of either herbicide in 127 wells sampled throughout rice-growing regions of the state (Marade and Segawa, 1988).

Screen for Atrazine, Bromacil, Prometon, and Simazine plus Diuron

Of the 90 wells that were analyzed for atrazine, bromacil, prometon, and simazine, one well in Tehama County was confirmed positive for atrazine, prometon, and simazine (Table 24). The bromacil analysis found no detectable levels. The detection limit for the four herbicides was 0.10 ppb. The well was also analyzed and confirmed positive for diuron. The two other wells which were analyzed for diuron had no detectable levels of the herbicide. The detection limit for diuron was 0.01 ppb. These herbicides have previously been found in Glenn County well water during an EHAP study. In 1986, 137 wells were sampled in Glenn county and detectable levels of at least one of the herbicides were found in 44 of the wells (Segawa, et al, 1986).

Quality Control

Bentazon

CDFA method validation recoveries averaged $92 \pm 15\%$ (n=10, 5 at 0.5 ppb and 5 at 2.0 ppb).

All blank matrix samples had no detectable levels of bentazon. CDFA recoveries on blank matrix spikes averaged $90 \pm 8.9\%$ (n=23, 2 ppb spike level), indicating good accuracy and precision. Enseco recoveries averaged $74 \pm 21\%$ (n=28, 2 at 0.2 ppb, 10 at 0.5 ppb, and 16 at 10 ppb). The Enseco recoveries were less accurate and less precise.

CDFA recoveries on blind spikes averaged $91.6 \pm 15.8\%$ (n=7, 2 at 2ppb and 5 at 3 ppb). Enseco recoveries averaged $79 \pm 21\%$ (n=6, all at 3 ppb). Again the CDFA recoveries showed greater accuracy and precision. All wells had sample verification. Of the 63 positive wells, seven were analytically verified by two methods, 33 were analytically verified by two laboratories, and 23 were analytically verified by both two methods and two laboratories.

Pairs of samples from four wells were analyzed by CDFA yielding a relative percent difference of $12.8 \pm 7.3\%$ (between 5.5 and 20.1%). Fifteen pairs of samples were analyzed by Enseco yielding a relative percent difference of $26.7 \pm 19.6\%$ (between 7.1 and 46.3%). When one sample from each of 53 pairs was analyzed by CDFA and the other was analyzed by Enseco, the resulting relative percent difference was $38.2 \pm 25.1\%$ (between 13.1 and 63.3%).

None of the field blanks had detectable levels of bentazon (MDL = 0.10 - 0.50 ppb).

MCPA

CDFA method validation recoveries averaged $88 \pm 6.3\%$ (n=10). None of the blank matrix samples had detectable levels of MCPA. The recoveries for the blank matrix spikes (1.0 ppb) averaged $62 \pm 32\%$, considerably lower accuracy and precision than for bentazon analysis..

Thiobencarb and Molinate

None of the blank matrix samples had detectable levels of thiobencarb or molinate. The recoveries for the blank matrix spikes (10.0 ppb) averaged $93 \pm 1.4\%$ for thiobencarb, and $67 \pm 9.9\%$ for molinate. The accuracy and precision for thiobencarb was quite high. Molinate recoveries showed much less accuracy and precision.

Screen for Atrazine, Bromacil, Prometon, and Simazine

None of the blank matrix samples had detectable levels of atrazine, simazine, prometon, or bromacil. Blank matrix spike (1.0 ppb) recoveries averaged $98 \pm 12\%$ for atrazine, $101 \pm 14\%$ for simazine, $101 \pm 14\%$ for prometon, and $102 \pm 16\%$ for bromacil. The accuracy was high and the precision was adequate.

Sample verification and analytical verification (as described under ben-tazon quality control) were obtained for positive samples during subsequent sampling.

For additional information on the quality control program, see Appendix II.

Table 4. Results of phase I well sampling for bentazon in Glenn County, December 1988. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
26	19N/01W-30	1 ^b	13.70 ^c 12.90	--- ^d	0	189	0
27	19N/01W-30	2	4.30 ^c 2.90	---	0	189	0
28	19N/01W-30	3	2.99 ^c 2.63	---	0	189	0
	19N/01W-31	4	ND ^e ND	---	44	0	0
	19N/01W-31	5	ND ND	---	44	0	0
37	19N/02W-36	6	1.23 ^c 1.04	---	103	176	164

^a Information on bentazon use is from CDFA Pesticide Use Reports.

^b The original positive reported by the Central Valley Regional Water Quality Control Board.

^c Sample confirmed by mass spectrometry.

^d --- = no additional analyses performed.

^e ND = None Detected, detection limit = 0.50 ppb for bentazon.

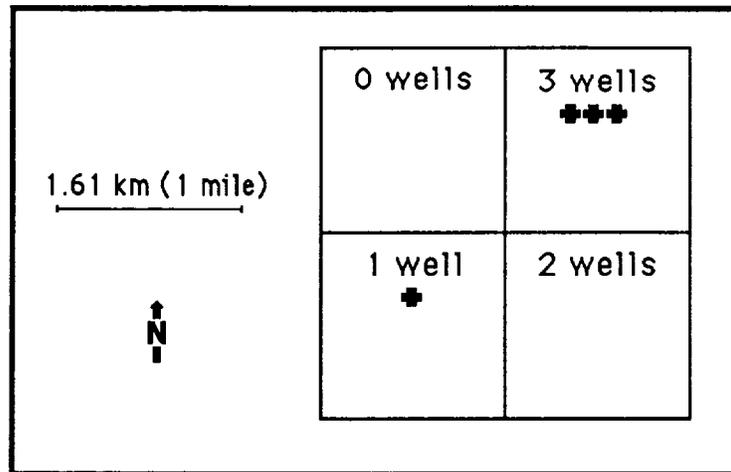


Figure 6. The distribution of the six wells sampled for bentazon during phase I, December 1988, showing the number of wells which tested positive (+) for bentazon in the four-section area of Glenn County.

Table 5. Results of phase II well sampling for bentazon in Glenn County, January 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
	18N/01W-06	1	ND ^b	--- ^c	0	0	0
16	18N/01W-06	2	ND 1.88 ^d	---	0	0	0
18	18N/02W-01	1	1.71 0.32 ^d	---	33	84	0
19	18N/02W-01	2	0.26 0.63 ^d	---	33	84	0
	18N/02W-02	1	0.39 ^d ND	---	107	24	0
23	18N/02W-12	1	ND 13.20 ^d 5.70 6.70 ^e 6.30 ^e	---	90	76	0
	19N/01W-16	1	ND	---	0	0	0
25	19N/01W-19	1	ND 0.18 ^d ND	---	0	0	718 ^f
	19N/01W-19	2	ND 0.10 ^g 0.10 ^g ND	---	0	0	718 ^f
	19N/01W-22	1	ND	---	0	0	0
	19N/01W-28	1	ND 0.16 ^d ND	---	0	0	0
	19N/01W-28	2	ND ND ND ^h ND ^h ND ^h	---	0	0	0
	19N/01W-32	1	ND	---	157	142	146
	19N/01W-32	2	ND	---	157	142	146
	19N/02W-13	1	ND	---	30	33	34
33	19N/02W-23	1	ND 1.00 0.72 ^d	---	201	118	24

Table 5. continued...

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section		
					1985 (kg)	1986 (kg)	1987 (kg)
34	19N/02W-23	2	6.21 ^d 4.29	---	201	118	24
	19N/02W-24	1	ND ND	---	17	17	0
	19N/02W-34	1	ND ND	---	15	248	19
	19N/02W-34	2	ND ND	---	15	248	19
	19N/02W-35	1	ND ND	---	64	239	120
	36	19N/02W-35	2	1.35 ^d 1.08	---	64	239
38	19N/02W-36	1	1.12 ^d 0.83	---	103	176	164
	19N/02W-36	2	ND ND	---	103	176	164

^aInformation on bentazon use is from CDFA Pesticide Use Reports.

^bND = None Detected, detection limit = 0.10 ppb for bentazon.

^c--- = no additional analyses performed.

^dSample confirmed by mass spectrometry.

^eResults from resampling done in April, 1989.

^fThis number exceeds the maximum amount of bentazon (581 kg) which can be applied to one section. It may reflect an error in reporting or data entry.

^gThe original samples yielded only one positive. To obtain sample verification the well was resampled and confirmed positive.

^hThe original samples yielded only one positive. The well was resampled but no detectable levels of bentazon were found. The criteria for sample verification were not met, and the well is considered negative for bentazon.

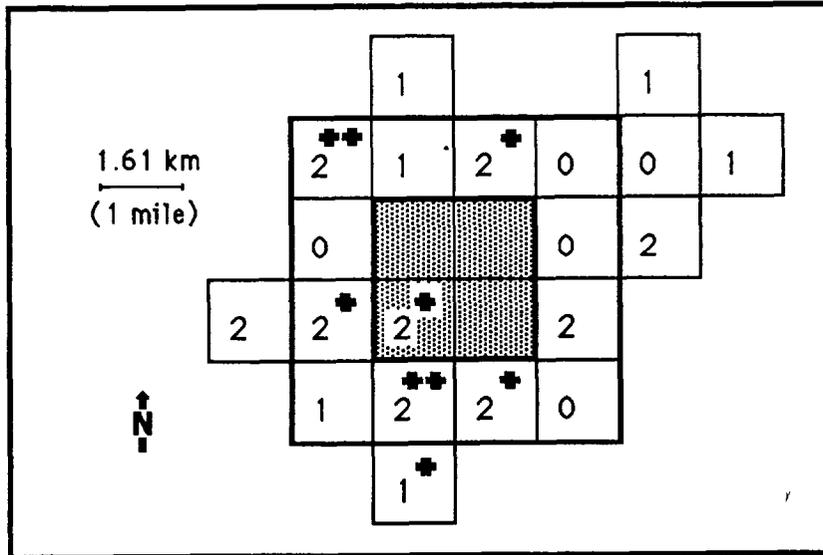


Figure 7. The distribution of the 24 wells sampled for bentazon during phase II, January 1989, showing the number of wells which tested positive (♣) for bentazon in each of the 15 sections of Glenn County. The shaded area represents the four-section area of phase I.

Table 6. Results of phase III well sampling for bentazon in Colusa County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
09	17N/02W-01	1	ND ^c	ND ^d = A,B, P,S	0	0	0
	17N/02W-01	2	ND	ND = A,B, P,S	0	0	0
	17N/02W-02	1	1.09 0.59	ND ^e = M,T	33	50	0
	17N/02W-04	1	ND	--- ^f	92	56	0
	17N/02W-08	1	ND	ND = A,B, P,S	76	52	78
	17N/03W-02	1	ND	ND = A,B, P,S	49	109	0
	17N/03W-03	1	ND	ND = A,B, P,S	44	52	0
	17N/03W-11	1	ND	ND = A,B, P,S	79	71	0
10	18N/01W-18	1	0.14 0.13	ND = M,T ND = A,B, P,S	35	0	0
	18N/01W-19	1	1.88 ^g 0.99	ND = M,T ND = A,B, P,S	0	0	0
11	18N/02W-13	1	ND	ND = A,B, P,S	0	30	0
	18N/02W-18	1	ND	---	0	17	0
	18N/02W-19	1	1.53 0.95	ND = M,T	17	17	0
	18N/02W-24	1	ND	---	330	306	0
13	18N/02W-24	2	1.31 0.87	ND = M,T	330	306	0
14	18N/02W-25	1	0.31 0.24	ND = M,T ND = A,B, P,S	54	28	0
	18N/02W-34	1	ND	---	0	0	0
15	18N/02W-35	1	ND	---	107	15	34
	18N/02W-35	2	2.81 ^g 1.36	ND = M,T	107	15	34

Table 6. continued...

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, M = molinate, P = prometon, S = simazine, and T = thiobencarb.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e ND = None Detected, detection limit = 0.20 ppb for molinate and thiobencarb.

^f --- = no additional analyses performed.

^g Sample confirmed by mass spectrometry.

Table 7. Results of phase III well sampling for bentazon in Glenn County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	18N/01W-07	1	ND ^c	ND ^d = A,B, P,S	91	0	0
17	18N/01W-07	2	0.42 0.21	ND ^e = M,T ND ^f = C	91	0	0
20	18N/02W-01	3	0.66 0.55	ND = M,T ND = A,B, P,S	33	84	0
21	18N/02W-06	1	3.99 3.15	ND = C	196	163	0
22	18N/02W-06	2	0.24 0.18	ND = M,T ND = C	196	163	0
	18N/02W-11	1	ND	ND = A,B, P,S	105	0	52
24	18N/03W-10	1	0.20 0.10	ND = M,T ND = C	0	0	0
29	19N/02W-07	1	0.31 0.22	ND = M,T ND = A,B, P,S	178	214	36
30	19N/02W-07	2	1.28 0.64	ND = M,T ND = C	178	214	36
	19N/02W-10	1	ND	ND = A,B, P,S ND = C	325	145	78
	19N/02W-15	1	ND	ND = A,B, P,S ND = C	101	20	55
	19N/02W-18	1	ND	ND = A,B, P,S	200	253	297
31	19N/02W-19	1	4.24 2.23	ND = M,T ND = C	122	69	11
32	19N/02W-22	1	0.68 0.64	ND = M,T ND = C	106	162	0
	19N/02W-23	3	ND	ND = A,B, P,S ND = C	201	118	24
35	19N/02W-28	1	2.61 1.64	ND = M,T	44	113	113
	19N/02W-29	1	ND	ND = A,B, P,S	105	0	0
	19N/02W-29	2	ND	ND = A,B, P,S	105	0	0

Table 7. continued...

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section		
					1985 (kg)	1986 (kg)	1987 (kg)
	19N/02W-30	1	ND	ND = A,B, P,S ND = C	279	47	18
	19N/02W-31	1	ND	ND = A,B, P,S	149	88	117
	19N/03W-11	1	ND	ND = A,B, P,S	153	91	27
39	19N/03W-12	1	3.27 3.17	ND = M,T ND = C	106	29	51
	19N/03W-15	1	ND	ND = A,B, P,S ND = C	52	68	0
	19N/03W-22	1	ND	ND = A,B, P,S ND = C	0	140	33
40	19N/03W-25	1	1.37 0.91	ND = M,T ND = A,B, P,S	160	77	65
	19N/03W-26	1	ND	ND = A,B, P,S ND = C	48	36	94
	19N/03W-27	1	ND	ND = A,B, P,S	48	82	0
	19N/03W-34	1	ND	ND = A,B, P,S	88	78	128
41	19N/03W-36	1	0.45 0.27	ND = M,T ND = A,B, P,S	0	188	59

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, C = MCPA, M = molinate, P = prometon, S = simazine, and T = thiobencarb.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e ND = None Detected, detection limit = 0.20 ppb for molinate and thiobencarb.

^f ND = None Detected, detection limit = 0.10 ppb for MCPA.

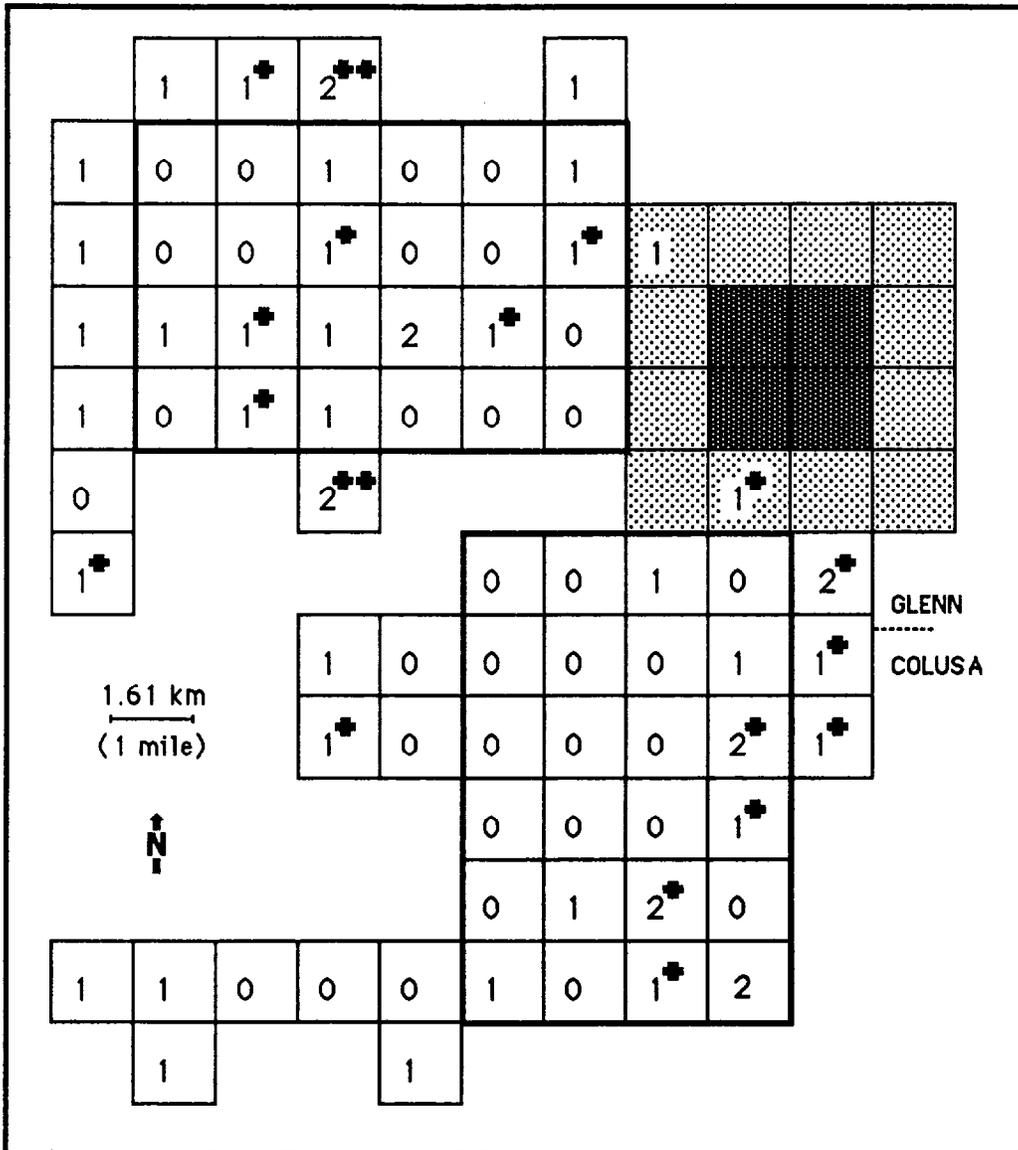


Figure 8. The distribution of the 48 wells sampled for bentazon during phase III, February 1989, showing the number of wells which tested positive (+) for bentazon in each of the 41 sections of Glenn and Colusa counties. The phase I area is darkly shaded, the phase II area is lightly shaded, and the proposed sampling area is outlined by a solid, dark line.

Table 8. Results of phase IV well sampling for bentazon in Kern County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
	31S/28E-33	1	ND ^b	--- ^c	0	0	0
	32S/28E-04	1	0.18 ^{d,e}	---	0	0	0
			ND				
			ND				
			ND				

^aInformation on bentazon use is from CDFA Pesticide Use Reports.

^bND = None Detected, detection limit = 0.10 ppb for bentazon.

^c--- = no additional analyses performed.

^dSample confirmed by mass spectrometry.

^eNo other samples from this well had detectable levels of bentazon. Because only one sample was positive, the criteria for sample verification were not met and the well is considered negative.

Table 9. Results of phase IV well sampling for bentazon in Madera County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	12S/14E-25	1	ND ^c	ND ^d = A,B, P,S	0	0	29
	12S/14E-26	1	ND	--- ^e	0	0	10
	12S/14E-26	2	ND	ND = A,B, P,S	0	0	10

^aAbbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^bInformation on bentazon use is from CDFA Pesticide Use Reports.

^cND = None Detected, detection limit = 0.10 ppb for bentazon.

^dND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e--- = no additional analyses performed.

Table 10. Results of phase IV well sampling for bentazon in San Joaquin County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	01S/08E-11	1	ND ^c	ND ^d = A,B, P,S	0	0	111
	01S/08E-12	1	ND	--- ^e	2	8	78
	01S/09E-05	1	ND	ND = A,B, P,S	0	0	52 ^f
	01S/09E-08	1	ND	---	6	0	71
	01S/09E-09	1	ND	ND = A,B, P,S	0	18	80
	01S/09E-14	1	ND	ND = A,B, P,S	0	83	109
	01S/09E-16	1	ND	---	0	15	56
	01S/09E-17	1	ND	ND = A,B, P,S	2	7	44
	01S/09E-22	1	ND	---	0	0	57
	01S/09E-24	1	ND	ND = A,B, P,S	0	18	119

^aAbbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^bInformation on bentazon use is from CDFA Pesticide Use Reports.

^cND = None Detected, detection limit = 0.10 ppb for bentazon.

^dND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e--- = no additional analyses performed.

^fAmount used in both San Joaquin and Stanislaus counties in section.

Table 11. Results of phase IV well sampling for bentazon in Tehama County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	24N/04W-10	1	ND ^c	---	0	8	27
			ND				
	24N/04W-10	2	ND	ND ^e = A,B, P,S	0	8	27
			ND				
	25N/03W-21	1	ND	ND = A,B, P,S	0	92	0
			ND				
	25N/03W-23	1	ND	---	0	0	15
			ND				
	25N/03W-23	2	ND	A = 0.48 ^f	0	0	15
			ND	S = 0.37			
				ND = B,P			
				A = 0.44 ^g			
				0.45			
				D = 0.07			
				0.10			
				0.11			
				0.13			
				P = 0.24			
				0.25			
				S = 0.24			
				0.24			
				ND = B			
	25N/03W-32	1	ND	ND = A,B, P,S	0	0	0
			ND				
	27N/03W-23	1	ND	ND = A,B, P,S	0	0	7
			ND				
	27N/03W-23	2	ND	---	0	0	7
			ND				

Table 11. continued...

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, S = simazine, and D = diuron.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d --- = no additional analyses performed.

^e ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^f The well was originally sampled on 2/15/89. Only one sample was available for analysis, so the criteria for sample verification and analytical verification could not be met. The well was considered an unconfirmed positive for atrazine and simazine.

^g The well was resampled on 5/25/89 to confirm the presence of atrazine and simazine. A sample was also analyzed for diuron with a detection limit of 0.01 ppb. The criteria for sample and analytical verification were met and the well is considered positive for atrazine, diuron, prometon, and simazine.

Table 12. Results of phase IV well sampling for bentazon in Merced County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
44	07S/13E-35	1	2.40 ^c	ND ^d = A, B, P, S	0	0	10
	08S/12E-01	1	1.90 ^e	ND = A, B, P, S	0	0	0
	08S/13E-01	1	ND	ND = A, B, P, S	0	0	121
	08S/13E-03	1	ND	ND = A, B, P, S	0	0	19
	08S/13E-05	1	ND	ND = A, B, P, S	0	0	136
	08S/13E-06	1	ND	ND = A, B, P, S	0	0	110
	08S/13E-19	1	ND	ND = A, B, P, S	0	0	0
				ND	--- ^f	0	0

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c Sample confirmed by mass spectrometry.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e ND = None Detected, detection limit = 0.10 ppb for bentazon.

^f --- = No additional analyses performed.

Table 13. Results of phase IV well sampling for bentazon in Placer County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	11N/05E-06	1	ND ^c	---	17	0	51
	11N/05E-08	1	ND	ND ^e = A, B, P, S	0	0	0
	11N/05E-17	1	ND	ND = A, B, P, S	17	29	98
	11N/05E-18	1	ND	ND = A, B, P, S	127	67	10
	11N/05E-23	1	ND	---	0	0	0
	12N/05E-30	1	ND	---	68	184	183
	12N/05E-30	2	ND	ND = A, B, P, S	68	184	183
	12N/06E-19	1	ND	ND = A, B, P, S	0	0	0
45	13N/05E-23	1	1.10 ^f 1.01 0.46	ND = A, B, P, S	17	0	15
	13N/05E-36	1	ND	ND = A, B, P, S	0	31	69

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d --- = no additional analyses performed.

^e ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^f Sample confirmed by mass spectrometry.

Table 14. Results of phase IV well sampling for bentazon in Sacramento County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
46	09N/04E-05	1	ND ^c	ND ^d = A,B, P,S	14	28	117
	10N/04E-18	1	ND	ND = A,B, P,S	35	10	59
	10N/04E-24	1	ND	ND = A,B, P,S	0	61	107
	10N/04E-25	1	ND	ND = A,B, P,S	0	0	100
	10N/04E-26	1	ND	ND = A,B, P,S	0	17	27
	10N/04E-27	1	0.33 ^f 0.10 ^f	--- ^e	0	52	105
	10N/04E-30	1	ND	ND = A,B, P,S	0	0	0
	10N/04E-30	2	ND	---	0	0	0
	10N/04E-31	1	ND	ND = A,B, P,S	100	16	0
	10N/04E-32	1	ND	ND = A,B, P,S	14	50	0

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e --- = no additional analyses performed.

^f Sample confirmed by mass spectrometry.

Table 15. Results of phase IV well sampling for bentazon in Stanislaus County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	01S/10E-09	1	ND ^c	---	0	0	45
	01S/10E-18	1	ND	---	0	11	28
	01S/10E-33	1	ND	---	0	0	29
	02S/10E-06	1	ND	---	0	0	0
47	02S/12E-31	1	3.74 ^e	ND ^f = A, B, P, S	0	34	0
48	03S/09E-01	1	0.47	ND = A, B, P, S	54	0	53
	03S/10E-06	1	0.26	ND = A, B, P, S	48	47	86
	03S/11E-07	1	ND	ND = A, B, P, S	0	0	75
	03S/12E-05	1	ND	---	42	75	78
49	03S/12E-06	1	0.98	ND = A, B, P, S	49	65	42
			0.73				

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, and S = simazine.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d --- = no additional analyses performed.

^e Sample confirmed by mass spectrometry.

^f ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

Table 16. Results of phase IV well sampling for bentazon in Yolo County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
57	08N/03E-19	1	ND ^c	ND ^d = A,B, P,S	0	0	198
	09N01E-17	1	ND 4.45 ^e 4.30	--- ^f	0	0	0
	09N/01E-28	1	ND	ND = A,B, P,S	0	0	54
	09N/01W-07	1	ND	ND = A,B, P,S	38	0	0
	11N/02E-07 11N/02E-20	1 1	ND ND	--- ND = A,B, P,S	0 0	32 0	50 0
58	12N/01E-24	1	0.50 0.24	B = 2.18 ^g S = 0.10 ND = A,P	0	0	0
	12N/01W-36	1	ND	ND = A,B,D ^h P,S	0	0	0
	12N/02E-30	1	0.36 0.28 0.16	---	0	0	0
59	12N/02E-30	2	ND	---	0	0	0

Table 16. continued...

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, P = prometon, S = simazine, and D = diuron.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e Sample confirmed by mass spectrometry.

^f --- = no additional analyses performed.

^g The well was originally sampled on 2/23/89. Only one sample was available for analysis, so the criteria for sample verification and analytical verification were not be met, and the well was considered an unconfirmed positive for bromacil and simazine.

^h The well was resampled on 5/24/89 to confirm the presence of bromacil and simazine. A sample was also analyzed for diuron with a detection limit of 0.10 ppb. The well contained no detectable levels of atrazine, simazine, diuron, prometon, or bromacil, and is considered negative.

Table 17. Results of phase IV well sampling for bentazon in Yuba County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
60	14N/04E-22	1	ND ^c ND	ND ^d = A,B, P,S ND ^e = C	404	44	238
	14N/04E-27	1	0.20 0.13	B = 0.50 ^f ND = A,P, S ND = C	38	422	355
	14N/04E-32	1	ND ND	ND = A,B, P,S ND = C	8	0	224
	15N/04E-33	1	ND ND	ND = A,B, P,S ND = C	32	84	420
	16N/04E-07	1	ND ND	ND = A,B, P,S ND = C	75	291	88
	16N/04E-22	1	ND ND ^h	ND = C	343	356	101
	16N/04E-24	1	1.80 ^h 1.50	ND = A,B, P,S ND = C	71	102	203
	16N/04E-26	1	0.83 0.39	ND = A,B, P,S ND = C	63	20	284
63	16N/04E-29	1	1.20 ^h 1.15 ^h	ND = C	119	118	9683 ⁱ
	16N/04E-31	1	ND ND	ND = A,B, P,S ND = C	0	0	323

Table 17. continued...

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, C = MCPA, P = prometon, S = simazine, and D = diuron.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e ND = None Detected, detection limit = 0.10 ppb for MCPA.

^f The well was originally sampled on 2/15/89. Only one sample was available for analysis, so the criteria for sample verification and analytical verification were not be met, and the well was considered an unconfirmed positive for bromacil.

^g The well was resampled on 5/25/89 to confirm the presence of bromacil. A sample was also analyzed for diuron with a detection limit of 0.10 ppb. The well contained no detectable levels of atrazine, simazine, diuron, prometon, or bromacil, and is considered negative.

^h Sample confirmed by mass spectrometry.

ⁱ This number exceeds the maximum amount of bentazon (581 kg) which can be applied to one section. It may reflect an error in reporting or data entry.

Table 18. Results of phase IV well sampling for bentazon in Sutter County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides ^a (ppb)	Bentazon Use in Section ^b		
					1985 (kg)	1986 (kg)	1987 (kg)
	11N/04E-19	1	ND ^c ND	ND ^d = A, B, P, S ND ^e = C	171	54	223
50	12N/04E-26	1	3.30 1.80	ND = C	188	115	184
51	12N/04E-26	2	1.00 0.69	ND = A, B, P, S ND = C	188	115	184
	12N/04E-36	1	ND ND	ND = A, B, P, S ND = C	0	0	178
52	13N/04E-24	1	8.85 ^f 8.30 6.40 ^f	ND = C	165	128	61
53	13N/04E-24	2	10.17 ^f 6.10	ND = A, B, P, S ND = C	165	128	61
54	13N/05E-18	1	3.76 ^f 3.36 ^f 2.40	ND = C	0	0	0
	14N/02E-03	1	ND ND	ND = A, B, P, S ND = C	162	0	120
55	15N/02E-35	1	0.92 0.59	ND = A, B, P, S ND = C	0	0	134
56	17N/02E-35	1	5.60 ^f 5.50 ^f	ND = A, B, P, S ND = C	61	96	36

^a Abbreviations for additional pesticide analyses. A = atrazine, B = bromacil, C = MCPA, P = prometon, and S = simazine.

^b Information on bentazon use is from CDFA Pesticide Use Reports.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d ND = None Detected, detection limit = 0.10 ppb for atrazine, bromacil, prometon, and simazine.

^e ND = None Detected, detection limit = 0.10 ppb for MCPA.

^f Sample confirmed by mass spectrometry.

Table 19. Results of phase IV well sampling for bentazon in Butte County, February 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
01	18N/01E-13	1	1.09	---	288	122	252
	19N/01E-12	1	0.95	---	91	166	0
02	19N/02E-01	1	ND ^c	---	186	122	0
	19N/02E-17	1	0.52	---	153	129	69
03	19N/02E-24	1	0.31	---	169	155	127
	19N/02E-28	1	ND ^d	---	142	151	213
04	19N/02E-28	1	4.46 ^d	---	203	128	176
	20N/01E-24	1	0.34	---	117	88	162
05	20N/01E-34	1	0.29	---	143	27	235
	20N/02E-08	1	3.28 ^d	---	36	0	184
06	20N/02E-08	1	2.50	---			
	20N/02E-35	1	0.63	---			
07	20N/02E-35	1	0.56	---			
			0.49	---			
08			0.48	---			

^a Information on bentazon use is from CDFA Pesticide Use Reports.

^b --- = no additional analyses performed.

^c ND = None Detected, detection limit = 0.10 ppb for bentazon.

^d Sample confirmed by mass spectrometry.

Table 20. Results of phase V well sampling for bentazon in Santa Barbara County, March 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
	09N/32W-08	1	ND ^b	--- ^c	0	0	10
	09N/33W-01	1	ND	---	14	0	5
	10N/33W-17	1	ND	---	4	3	2
	10N/33W-20	1	ND	---	7	0	5
	10N/33W-28	1	ND	---	29	32	12
	10N/33W-29	1	ND	---	0	11	12
	10N/34W-04	1	ND	---	0	2	3
	10N/34W-12	1	ND	---	0	24	21
	10N/34W-13	1	ND	---	14	24	13
	10N/34W-23	1	ND	---	0	0	20

^aInformation on bentazon use is from CDFA Pesticide Use Reports.

^bND = None Detected, detection limit = 0.10 ppb for bentazon.

^c--- = no additional analyses performed.

Table 21. Additional well sampling results for bentazon in Glenn County, April 1989. Wells are identified by township/range-section (T/R-S) and location code (LOC), a number assigned by the EHAP to distinguish between wells located in the same section. The Map ID is used to show the locations of positive wells in Appendix III.

MAP ID	T/R-S	LOC	Bentazon (ppb)	Other Herbicides (ppb)	Bentazon Use in Section ^a		
					1985 (kg)	1986 (kg)	1987 (kg)
43	19N/02W-08	1	0.47 0.46 ^c	--- ^b	52	46	69
42	20N/02W-31	1	2.10 1.40 ^c	---	255	68	16

^aInformation on bentazon use is from CDFA Pesticide Use Reports.

^b--- = no additional analyses performed.

^cSample confirmed by mass spectrometry.

Table 22. Summary of results of MCPA analyses performed, from February to April 1989, on bentazon backup samples from Glenn, Sutter, and Yuba counties, showing the number of wells and sections sampled in each county, and the number of positive wells and sections.

County	-----Wells-----		-----Sections-----	
	Sampled	Positive	Sampled	Positive
Glenn	15	0 ^a	14	0
Sutter	10	0	8	0
Yuba	10	0	10	0

^aThe detection limit for MCPA was 0.10 ppb in all counties.

Table 23. Summary of results of molinate and thiobencarb analyses performed, from February to April 1989, on bentazon backup samples from Glenn and Colusa counties, showing the number of wells and sections sampled in each county, and the number of positive wells and sections.

County	-----Wells-----		-----Sections-----	
	Sampled	Positive	Sampled	Positive
Glenn	12	0 ^a	11	0
Colusa	7	0	7	0

^aThe detection limit for molinate and thiobencarb was 0.20 ppb in all counties.

Table 24. Summary of results of atrazine, bromacil, prometon and simazine analyses performed, from February to April 1989, on bentazon backup samples from 12 California counties, showing the number of wells and sections sampled in each county, and the number of positive wells and sections.

County	-----Wells-----		-----Sections-----		Herbicide(s) Found
	Sampled	Positive	Sampled	Positive	
Colusa	10	0 ^a	9	0	---
Glenn	20	0	19	0	---
Madera	2	0	2	0	---
Merced	6	0	6	0	---
Placer	7	0	7	0	---
Sacramento	8	0	8	0	---
San Joaquin	6	0	6	0	---
Stanislaus	5	0	5	0	---
Sutter	7	0	6	0	---
Tehama	5	1 ^b	5	1	Atrazine Diuron Prometon Simazine
Yolo	6	0 ^c	6	0	---
Yuba	8	0 ^c	8	0	---

^aThe detection limit for atrazine, bromacil, prometon, and simazine was 0.10 ppb in all counties.

^bThe well in Tehama County was originally sampled on 2/15/89. To obtain sample and analytical verification the well was resampled on 5/25/89. A sample was also analyzed for diuron with a detection limit of 0.10 ppb. The criteria for sample and analytical verification were met and the well is considered positive for atrazine, diuron, prometon, and simazine.

^cOne well in Yolo County and one well in Yuba County were analyzed for diuron in addition to the four other herbicides. The detection limit was 0.10 ppb for diuron. Detectable levels of diuron were not found in either well.

SUMMARY AND CONCLUSIONS

A total of 190 wells in 159 sections were sampled for bentazon, and 63 wells in 53 sections were confirmed positive for bentazon (Table 25). The sampled wells were located in 15 counties in California. Positives were found in 10 of those counties.

Of the 16 counties with the highest reported bentazon use, 15 were sampled. The highest ratio of positives to wells sampled (8 of 10) was in Butte County, which also had the highest 1987 bentazon use (17,753 kg).

Because none of the field blanks had detectable levels of bentazon and sampling was completed before 1989 bentazon applications were to begin, it is unlikely that any of the samples were inadvertently contaminated during sampling.

Ninety of the wells were also analyzed for atrazine, bromacil, prometon, and simazine. Three of these wells were also analyzed for diuron. One well was confirmed positive for atrazine, simazine, prometon, and diuron. Samples from 19 wells analyzed for the rice herbicides thiobencarb and molinate were all negative. Thirty-five wells were analyzed for MCPA, another rice herbicide and no positives were found.

The absence of other rice herbicides suggests that the wells sampled and the associated soils are not particularly vulnerable to all pesticides

used on rice, so the properties of bentazon under rice growing conditions appear to contribute to its transport and/or longevity in ground water. However, since the exact origin of the bentazon residues found in any given well is unknown, it is possible that ground water movement transported bentazon from one section to another section.

The high percentage of confirmed bentazon positives collected over a wide area of California suggests that the herbicide has reached ground water in the course of its legal agricultural use in rice growing areas of California. In order to understand the pathways for contamination, investigations are needed to determine the causes and sources of contamination.

Table 25. California counties which had reported 1987 bentazon use showing the number of wells and sections sampled in each county, and the number of positive wells and sections.

County	Rank ^a	-----Wells-----		-----Sections-----	
		Sampled	Positive	Sampled	Positive
Butte	1	10	8	10	8
Yuba	2	10	4	10	4
Sutter	3	10	7	8	5
Glenn	4	61	28	42	20
Colusa	5	19	7	16	7
Placer	6	10	1	9	1
Sacramento	7	10	1	9	1
Yolo	8	10	3	9	3
San Joaquin	9 ^b	10 ^c	0	10	0
Fresno	10 ^b	-- ^c	--	--	--
Stanislaus	11	10	3	10	3
Merced	12	7	1	7	1
Kern	13	2	0	2	0
Madera	14	3	0	2	0
Tehama	15	8	0	5	0
Santa Barbara	16 ^d	10	0	10	0
Monterey	17 ^d	--	--	--	--
Contra Costa	18	--	--	--	--
San Benito	19	--	--	--	--
Santa Clara	20	--	--	--	--
San Luis Obispo	21	--	--	--	--
San Mateo	22	--	--	--	--
Santa Cruz	23	--	--	--	--
Los Angeles	24	--	--	--	--
Alameda	25	--	--	--	--
Sonoma	26	--	--	--	--
San Diego	27	--	--	--	--
Marin	28	--	--	--	--
Riverside	29	--	--	--	--

^a Rank based on amount of 1987 bentazon use. Use Data are from 1987 CDFA Pesticide Use Reports.

^b No wells were available for sampling in the bentazon use areas of Fresno county.

^c -- = No wells or sections sampled.

^d No attempt was made to sample counties ranked 17 - 29.

REFERENCES

- Cardozo, C. et al. 1988. Sampling for Pesticide Residues in California Well Water. 1988 Update, Well Inventory Database. California Department of Food and Agriculture. 151 pp.
- Kishlushko, P.M. 1982. Bentazon Hydrolysis. *Agrokhimia* 11:127- 130.
- Marade, S.J. and R.T. Segawa. Sampling for Residues of Molinate and Thiobencarb in Well Water and Soil in the Central Valley. California Department of Food and Agriculture. 1988.
- Segawa, R.T., R. Maykowski and R.J. Sava. Survey for Triazine Herbicides in Well Water, Glenn County, 1986. California Department of Food and Agriculture. 1986.

APPENDIX I. ANALYTICAL METHODS

CALIFORNIA DEPT. OF FOOD & AGRIC.
CHEMISTRY LABORATORY SERVICES
ENVIRONMENTAL MONITORING SECTION
3292 Meadowview Road
Sacramento, CA 95832
(916)+427-4998/4999

Original Date:??
Supercedes: NEW
Current Date:06/08/1989
Method #:

BENTAZON

SCOPE:

This method has been used to determine bentazon in water .

PRINCIPLE:

Bentazon is extracted from water by methylene chloride under acidic condition after the interferences has been removed from the sample under basic condition . The analyte is then methylated with diazomethane to allow gas chromatography analysis .

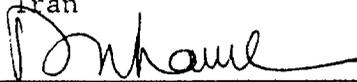
REAGENTS AND EQUIPMENT:

Seperatory funnel 2000 ml
Methylene chloride
Isooctane
Diethyl ether
Sulfuric acid concentrate
Sodium hydroxide 25%(w/w)
PH paper
Sodium sulfate, anhydrous
Diazomethane
Graduated test tube
Nitrogen evaporator

ANALYSIS:

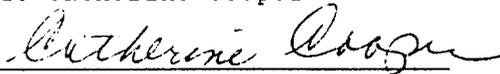
- 1) Record the weight by difference and transfer the sample to a 2000 ml funnel.
- 2) Adjust the pH of the separatory funnel contents to above 10 with 25% sodium hydroxide . Use pH paper as a pH reader .
- 3) Extract the sample two times with 70 ml methylene chloride each time . Discard the extracts .
- 4) Adjust the pH of the separatory funnel content to below 2 with concentrated sulfuric acid . Use pH paper as pH reader .
- 5) Extract the sample three times with 70 ml methylene chloride each time. Drain the extracts into a 500 ml boiling flask through a funnel containing 25 grams of sodium sulfate with #4 filter paper.
- 6) Wash the sodium sulfate with 70 ml methylene chloride .
- 7) Add 5ml of isooctane to the boiling flask .
- 8) Evaporate the flask containing methylene chloride to a volume about 2 ml with a rotoevaporator that is set at 35°C.
- 9) Transfer the concentrated solution to a graduated test tube using about 8 ml diethyl ether or more .
- 10) Evaporate the extract at a temperature of 30°C under a nitrogen stream to a volume of 1 ml or less .

WRITTEN BY: Duc Tran



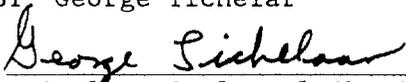
TITLE: Agricultural Chemist I

REVIEWED BY: Catherine Cooper



TITLE: Agricultural Chemist III

APPROVED BY: George Tichelar



TITLE: Principal Agricultural Chemist

STANDARD
OPERATING
PROCEDURE

Subject or Title:
Thiocarbamates and Basagran (Bentazon) in Water

Page 1 of 6

SOP No.:
LM-CAL-4089

Revision No.:
Three

Effective Date:
July 24, 1989

Supersedes: LM-CAL-4089, June 2, 1989

1. PROCEDURE

1.1 Rinse all glassware with the three solvents as usual (acetone, hexane, and methylene chloride), and additionally with methanol.

1.2 The method blank and the matrix spike and matrix spike duplicate, use distilled water (methylene chloride rinsed) UNLESS otherwise instructed:

1.2.1 Measure 500 mL or the specified amount of distilled water into a 1-L separatory funnel.

1.2.2 Extract with two 50 mL portions of methylene chloride.

1.2.3 Discard the methylene chloride, and the water is ready to be used as the MB, and/or as the MBMS/MBMSD.

1.3 Extraction.

1.3.1 Label two CAL IDs, one with the suffix 'BAS' and the other with the suffix 'THIO'.

1.3.2 Shake the sample well, and measure 500 mL (or the specified amount) into a 1-L separatory funnel. Record the volume used.

1.3.3 If applicable, add the appropriate spiking solutions.

1.3.4 No surrogates are added to the samples.

Prepared By:
Dennis E. Gall

Date:
July 24, 1989

Management Approval:

Date:

QA Officer Approval:

Date:

[Handwritten signature]
[Handwritten signature]

7/24/89
7/24/89

STANDARD
OPERATING
PROCEDURE

Subject or Title:
Thiocarbamates and Basagran (Bentazon) in Water

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SOP No.:
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Three

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1.4 Base-Neutral Extraction for 'THIO'.

1.4.1 Adjust the pH to > 12 with sodium hydroxide solution.

1.4.1.1 Check the pH with the pH paper.

1.4.2 Extract with three 60 mL portions of methylene chloride, shake 2 minutes for each extraction. Check pH (before extracting) each time to ensure that pH is basic.

1.4.2.1 Vent frequently.

1.4.2.2 Allow the phases to separate for 10 minutes.

1.4.3 Collect in the 250-mL Erlenmeyer flask. If THIO fraction is not required then discard this fraction, and proceed to 1.5 and follow 'BAS'.

1.4.4 Ready for KD concentration.

1.5 Acid Extraction for 'BAS'.

1.5.1 Adjust the pH to < 2 with concentrated sulfuric acid (methylene chloride rinsed).

1.5.1.1 Check the pH with the pH paper.

1.5.2 Extract with three 60 mL portions of methylene chloride, shaking 2 minutes for each extraction.

1.5.2.1 Vent frequently.

1.5.2.2 Allow the phases to separate for 10 minutes.

1.5.3 Pass the methylene chloride extract through ca 30g of sodium sulfate (rinsed with methylene chloride) into a 300 mL round bottom flask.

1.5.4 Rinse the sodium sulfate with methylene chloride, and collect in the round bottom flask.

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2. CONCENTRATION

2.1 'THIO' by KD.

- 2.1.1 Pour the extracts through sodium sulfate in a filtering funnel plugged with a small wad of glass wool into a K-D flask; a 10 mL concentrator tube attached to the 500 mL reservoir.
- 2.1.2 Allow the extract to drain.
 - 2.1.2.1 Rinse the sample flask with methylene chloride several times.
 - 2.1.2.2 Pour the rinseates through the sodium sulfate each time into the KD flask.
- 2.1.3 Add several small teflon boiling chips and attach the 3-ball macro-Synder column.
 - 2.1.3.1 Prewet the column with methylene chloride.
 - 2.1.3.2 Concentrate the extract to ca 6 mL on the steam bath at ca 80-85° C.
- 2.1.4 Remove the KD flask from the bath and allow it to cool on the ring support for a minimum of 10 minutes.
- 2.1.5 CAREFULLY disassemble the concentrator tube.
 - 2.1.5.1 Rinse the lower glass joint with a small amount of methylene chloride.
- 2.1.6 Transfer the extract with methylene chloride quantitatively to a 16 mL test tube.
- 2.1.7 Reduce the extracts under nitrogen, exchange the solvent to isooctane and adjust the final volume to 1.0 mL; 500 mL/1.0 mL.
- 2.1.8 Sample extracts are ready for GC-NPD.

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2.2 'BAS' by Rotary Evaporation.

- 2.2.1 Add 5 mL of isooctane as a solvent keeper.
- 2.2.2 Concentrate the extract to 4-6 mL on the rotary evaporator with the water bath at 30° C.
- 2.2.3 Transfer quantitatively with diethyl ether (three 2 mL rinses) to a graduated centrifuge tube.
- 2.2.4 Reduce the extracts under nitrogen to ca 1 mL (NOT TO NEAR DRYNESS) and prepare for methylation (derivatization).

3. DERIVATIZATION

3.1 With Ethereal Diazomethane/Adjustment of 'BAS'.

- 3.1.1 Ethereal diazomethane should be used in the hood.
- 3.1.2 Keep it cold when not being used (use it when the set of extracts are ready).
- 3.1.3 Cautiously add 1 mL of ethereal diazomethane to the concentrated extract in the centrifuge tube.
- 3.1.4 Mix gently.
- 3.1.5 Add more ethereal diazomethane if the yellow color dissipates.
- 3.1.6 Allow the solution to stand for 15 minutes at room temperature.
- 3.1.7 Reduce under nitrogen to purge the excess diazomethane, and exchange the solvent to isooctane to strip off the diethyl ether. (Do not allow the extracts to go below 0.5 mL).
- 3.1.8 Adjust the final volume to 1.0 mL in isooctane: 500 mL/1mL.
- 3.1.9 Transfer the extracts to the 8 mL test tube.
- 3.1.10 Ready for GC-NP or GC/MS.
- 3.1.11 To prepare for GC/MS SIM, spike with d₁₀ phenanthrene so as to produce a final concentration of 40 ug/mL. Quantitate bentazon based on the d₁₀ phenanthrene.

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4. GC-TSD OPERATING CONDITION

The gas chromatography operating conditions are as follows:

Instrument: Varian 3400 or 3700
Data System: Varian 402 or 654
Detector: Thermionic Specific Detector
Column: 15m DB-5 megabore, 0.56mm ID
J & W Silica Coated DB-5
- 5% phenyl
- 95% methyl silicone
- 1.5 u film thickness

Temperatures:

Injector: @ 220° C
Detector: @ 320° C
Column: Initial Temp: 180° C
Hold for 3 minutes
Program Temp: 20 degrees/minutes
Final Temp: 240° C
Hold for: 2 minutes

Gas Flows:

Helium Carrier: 20 mL/min.
Nitrogen makeup: 10 mL/min.
Detector Hydrogen: 4 mL/min.
Detector Air: 60 mL/min.

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5. GCMS-SIM OPERATING CONDITIONS

The GCMS operating conditions are as follows:

Instrument: Finnigan 5100 (operating in SIM mode)

Column: 30m DB-5 narrow bore 0.25mm ID

Temperatures: Column: 450° C for four minutes
then to 280°C at 7.50 C/min

Injector: 275° C

Interface Oven Sep. temp: 280° C

Selected Ions:	<u>M/Z</u>	<u>Time</u>
	105 ± 0.25 amu	0.1 sec
	133 ± 0.25 amu	0.1 sec
	212 ± 0.25 amu	0.1 sec
	254 ± 0.25 amu	0.1 sec

6. QUALITY ASSURANCE/QUALITY CONTROL

6.1 The method blank is mandatory and is performed for each set of matrix, and for every 20 samples.

6.2 The matrix spike and the matrix spike duplicate are optional and must be requested. They are performed for each matrix and for every 20 samples.

6.3 Spike the MS/MSD with 100 uL of the Rice Herbicide solution to 500 mL of water to yield:

	<u>Standard Concentration</u>	<u>Spike Level</u>
Ordram (molinate)	50 ug/mL	10 ug/L (ppb)
Bolero (thiobencarb)	50 ug/mL	10 ug/L (ppb)
Bentazon	50 ug/mL	10 ug/L (ppb)

CALIFORNIA DEPT. OF FOOD & AGRIC.
ENVIRONMENTAL MONITORING SECTION
CHEMISTRY LABORATORY SERVICES
3292 Meadowview Road
Sacramento, CA 95832
(916)+427-4998/4999

Original Date: June 26, 1989
Supercedes: New
Current Date: June 26, 1989
Method #:

Analysis of MCPA in Well Water

SCOPE:

This method is for the extraction and gas chromatographic analysis of MCPA from well water.

PRINCIPLE:

MCPA, (4-chloro-2-methyl-phenoxy)acetic acid, is extracted from water, at a pH less than 2, with methylene chloride. The extract is methylated with Diazomethane and the derivative analyzed by gas chromatography.

REAGENTS AND EQUIPMENT:

1. Methylene chloride, pesticide grade
2. Isooctane, pesticide grade
3. Sulfuric acid, concentrated
4. Diazomethane solution (in ether)
5. Sodium sulfate, anhydrous
6. Separatory funnels, 2L
7. Funnels, 60° short glass-stem 3-4 inch diameter
8. Flasks, flat-bottom boiling, 500mL
9. Tubes, conical centrifuge - 15mL graduated
10. Assorted glassware for measuring and dispensing reagents as required
11. pH paper
12. Glass wool - Pyrex fiber glass silver 8 micron
Corning Glass Works
Corning, N.Y.
13. pH meter, Corning Model 145
14. Rotary evaporator, Buchi-Brinkman, R110
15. Analytical evaporator, N-EVAP - Organomation Associates Incorporated
Northborough, Ma.
16. Balance - Mettler PC 4400 - Mettler Instrument Corporation
Hightstown, N.J.
17. Gas chromatograph, equipped with Hall Detector in chlorine mode
18. Gas chromatograph, equipped with OI Detector in chlorine mode

ANALYSIS:

1. Weigh approximately 1000g of well-mixed water sample into a 2L separatory funnel.
2. Adjust the sample pH to less than 2 with concentrated H₂SO₄, checking with pH paper periodically and checking the final pH with a meter when it is below 2.

3. Extract the sample three times with 100mL each methylene chloride, venting frequently.
4. Drain the methylene chloride through -40g sodium sulfate into a 500mL boiling flask. After the last extraction, rinse the sodium sulfate with about 25 mL methylene chloride.
5. Add about 5mL isooctane to the sample flask and rotary evaporate in a 40°C water bath to 2 to 3mL. Repeat the process to insure removal of all methylene chloride.
6. Methylate the sample by adding about 3mL of Diazomethane to the boiling flask. Diazomethane is **EXPLOSIVE AND CARCINOGENIC-use caution** (Diazomethane must be added until yellow color persists). Swirl contents of flask to insure that any sample adhering to side of flask is mixed with Diazomethane. Cover the flask with aluminum foil and allow 20 minutes for methylation.
7. Rinse the methylated sample into a 15mL graduated test tube with about 10mL isooctane. Place the sample tube in a 40°C water-bath under a stream of nitrogen and bring to a final volume of 1mL to remove excess Diazomethane and ether. Allow sample to cool to room temperature and bring to a final volume of 2mL with isooctane.
8. Submit for gas chromatography using a Hall or OI Detector.

RECOVERY EFFICIENCY:

Average recoveries for the method at three different spike levels are listed in the following table.

<u>Spike Level</u> <u>(ug/1000g DI water)</u>	<u>ug MCPA Recovered</u>	<u>% Recovery</u>
1.0	0.81	81
2.0	1.82	91
10.0	8.68	87

Minimum detectable level = 0.1ppb

EQUIPMENT CONDITIONS:

Varian 3700 equipped with a Hall Electroconductivity Detector, in Halogen mode.

Injector: Splitless; 210°C

Detector: 250°C

Reactor: 845°C

Column: 50% Phenyl-methyl silicone megabore, 10M x 0.53mm

Carrier: Helium 20 mL/minute

Temperature: 160°C Isothermal

Vent: 1.0 minute

Range x Attenuation: 1 x 5

Varian 6000 equipped with an OI detector, Halogen mode.

Injector: Splitless; 210°C

Detector: 250°C

Reactor: 845°C

Column: Hewlett-Packard HP-5 Megabore

5% Diphenyl & 95% dimethyl polysiloxane

10M x 0.53mm x 2.62 micron

Carrier: Helium 22 mL/minute

Temperature Program: Temperature: 135°C for 1 minute

Program rate=20°C/minute

Final Temperature: 240°C/0.5 minute

Attenuation: 2

CALCULATIONS:

ppb MCPA =

$$\frac{\text{Amount standard Injected(ng)} \times \text{Area sample} \times \text{final sample volume(mL)} \times 1000}{\text{Area standard} \times \text{Volume sample injected(uL)}}$$

DISCUSSION:

Low recoveries result from allowing the sample to go to dryness during rotary evaporation.

REFERENCES:

E.P.A. Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples: EPA-600/8-80-038., Section 8.

Echelberry, J., "Analysis of Phenoxy Herbicides on Quartz Filters", Method 107, CDFA Chemistry Laboratory, Environmental Monitoring Section, Nov. 1985.

Fong, B., "Analysis of 2,4-D Herbicides from Handwashes", CDFA Chemistry Laboratory, Environmental Monitoring Section, Dec. 1986.

WRITTEN BY: Karen Hefner

Karen Hefner

TITLE: Agricultural Chemist II

APPROVED BY: Catherine Cooper

Catherine Cooper

TITLE: Agricultural Chemist III

APPROVED BY: George Tichelaar

George Tichelaar

TITLE: Principal Agricultural Chemist

CALIFORNIA DEPT. OF FOOD & AGRIC.
ENVIRONMENTAL MONITORING SECTION
CHEMISTRY LABORATORY SERVICES
3292 Meadowview Road
Sacramento, CA 95832
(916) 427-4999

Original Date: December 22, 1988
Supercedes: NEW
Current Date: December 22, 1988
Method #:

ATRAZINE, BROMACIL, DIURON, PROMETON, SIMAZINE IN WATER.

SCOPE:

This method has been developed and used for the analysis of Atrazine, Bromacil, Diuron, Prometon, and Simazine in water.

PRINCIPLE:

Atrazine, Bromacil, Diuron, Prometon and Simazine are extracted from water with dichloromethane. The solution is evaporated to dryness and redissolved in methanol. The extract is filtered and divided. One part is prepared for the GLC analysis of Atrazine, Bromocil, Prometon and Simazine. The other is for the HPLC analysis of Diuron.

REAGENTS AND EQUIPMENTS:

1. Methanol, HPLC grade.
2. Sodium Sulfate - Reagent, A.C.S.
Spectrum Chemical MFG. Corp.
3. Dichloromethane (glass distilled).
4. Balance - Mettler PC 4400 - Mettler Instrument Corp.
Hightstown, NJ.
5. Micro-Mate Syringes 10 cc - Popper and Sons Inc.
New Hyde Park, N.Y.
6. 2000 ml separatory funnels.
7. 500 ml flat-bottom boiling flasks.
8. Funnels, 60 degree short stem, 3-4 inch diameter.
9. Graduated conical centrifuge tube - 15 ml.
10. Meyers N-EVAP - Organomation Associates Incorporated.
Northborough, Ma.
11. Assorted glassware for measuring and dispensing reagents as required.
12. Thermolyne Vortex Maxi Mixer II - Sybron Corporation
Dubuque, Iowa
13. HPLC Filter - 0.2 microns, disposable Nylon 66, Serie 900
Non-sterile. Cat. No. 2091. Applied Science Labs.
Alltech Assoc. Inc.

ANALYSIS:

Extraction:

1. Collect water samples in one liter brown bottles and refrigerate until extraction which occurs within 48 hours after arrival.
2. Weigh by difference approximately 1000 grams of water and pour into a 2000 ml separatory funnel. For each sample set, prepare a blank of 800 grams distilled water and a spike of 800 grams of 1 ppb mix spike solution, placing each in a 1000 ml separatory funnel.
3. Add 100 ml dichloromethane to each sample and shake for 2 minutes, venting to release pressure.
4. Drain the dichloromethane through a glass wool funnel containing 20 g sodium sulfate into a 500 ml flat-bottomed boiling flask.
5. Repeat (3) and (4) twice using 80 ml dichloromethane. Rinse the sodium sulfate twice with 25 ml dichloromethane. Collect all extractions and dichloromethane in the 500 ml boiling flask.
6. Rotoevaporate the samples in a 35°C water bath under 15 inches vacuum pressure until near dry. Add 2-3 ml methanol to the flask and rotoevaporate again until near dry. Care is taken not to over heat.
7. Rinse the flask with methanol and quantitatively transfer sample to a 15 ml centrifuge tube. Bring to final volume of 3 ml under a stream of nitrogen at 50°C.

GLC and HPLC Preparation.

1. Place samples on the Maxi Mixer for 20 seconds.
2. Transfer entire sample to micro-mate syringe and filter sample using a 0.2 micron Nylon 66 HPLC non-sterile disposable filter.
3. Divide sample in half and place each half in a 2ml auto sampler vial. Submit for analysis by GLC and HPLC.

HPLC conditions for the determination of Diuron.

Perkin Elmer Series 4 HPLC with Varian variable wavelength UV detector Model 2550, Perkin Elmer Autosampler Model ISS 100, and Hewlett Packard Data System Model 3388A were used for the determination of Diuron in water samples. The parameters are listed as follows:

COLUMN: Altex Ultrasphere ODS C-18, 4.6 i.d. 150 mm length, 5 um partical size, Beckman 235330, Rainin Cat. No. 256-06.

In line filter: Holder-Rainin. Cat. No. 05-0149
Filter with seals. 0.5 micro-meters with seals.
Cat. No. 05-0155

MOBIL PHASE: 55% methanol and 45% water.

FLOW RATE: 1.0 mls/minute.

COLUMN TEMPERATURE: 35°C.

RETENTION TIME: Diuron 7.5 minutes.

MINIMUM DETECTION LIMIT: 0.5 ng.

WORKING RANGE: 0.5 ng to 100 ng.

DETECTOR PARAMETERS: 248 nm, range 0.001, lamp D2, absorbance unit 0.002.

INJECTION VOLUME: 20 microliters.

GLC conditions for Atrazine, Bromacil, Prometon and Simazine

Varian Model 3700 TSD with Hewlett Packard a 3388A Integrator and a 7672A Automatic Sampler were used for the determination of Atrazine, Bromacil, Prometon and Simazine in water samples. The parameters are listed as follows:

TEMPERATURE PROGRAM: T-1 170°C for 5 minutes.
Increasing rate 10°C per minute.
T-2 220°C per 2 minutes.

COLUMN: 10m * 0.53 mm HP-17. 50% Phenyl Methyl Silicone.

COLUMN FLOW: 10 ml per minute. Helium 99.995%.

HYDROGEN PRESSURE: 23 psig.

BEAD CURRENT: 5.80 A/mV.

INJECTOR TEMPERATURE: 210°C.

DETECTOR TEMPERATURE: 250°C.

Confirmation conditions on GLC.

INSTRUMENT: PERKIN-ELMER SIGMA 2. NPD.

COLUMN: Carbowax 2M. HP 20m - 10m * 0.53mm * 1.33uM.
HP part # 19095w-121.

COLUMN TEMPERATURE: 190°C.

COLUMN FLOW: 10 mls/minute.

HYDROGEN PRESSURE: 20 psig.

AIR PRESSURE: 30 psig.

BEAD CURRENT: 6.25 A/mV.

INJECTOR TEMPERATURE: 210°C.

DETECTOR TEMPERATURE: 350°C.

CALCULATIONS:

Report data in ppb.

$$\text{PPB} = \frac{(\text{peak ht sample})(\text{ng std injected})(\text{sample final volume ml})(1000)}{(\text{peak ht standard})(\text{ul injected})(\text{g of sample})}$$

REFERENCES:

1. Maykoski, Richard, "Atrazine and Simazine in Water", CDFA, Environmental Monitoring Section, Method 115, March 6, 1986.
2. Tran, Duc, "Triazine Pesticides in Water and Wastewater", CDFA, Environmental Monitoring Section, February 19, 1988.

WRITTEN BY: Karen Hefner

Karen Hefner

TITLE: Agricultural Chemist II

APPROVED BY: Catherine Cooper APPROVED BY: George Tichelaar

Catherine Cooper

TITLE: Agricultural Chemist III TITLE: Principal Ag. Chemist

George R. Tichelaar

APPENDIX II. QUALITY CONTROL DATA

Table 1. Method Validation Blank Matrix Spikes (% Recovery) for the Z015 Bentazon 1989 Well Water Project.

Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: CDFA
 Chemist: Duc Tran
 Date: 3/6/89

Lab Sample #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
2144	0.55	0.5	110			
2145	0.45	0.5	90			
2146	0.42	0.5	84			
2147	0.45	0.5	90			
2148	0.36	0.5	72	89	14	15
2150	1.58	2.0	78			
2151	2.24	2.0	112			
2152	1.82	2.0	91			
2153	2.30	2.0	115			
2154	1.64	2.0	82	96	17	18
OVERALL =				92	15	16

\bar{X}	SD	LWL	UWL	LCL	UCL
92	15	78	108	63	123

LWL and UWL = mean +/- SD, LCL and UCL = mean +/- 2 SD

Table 2. Continuing Quality Control Data for the Z015 Bentazon 1989 Well Water Project: Blank Matrix Spikes.

Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: CDFA
 Chemist: Duc Tran
 Date: 3/29/89

Extraction Set #	Lab Sample #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
258, 281, 287, 383, 395, 425, 458, 512, 524	1967	1.83	2.0	92			
251, 269, 317, 452, 506, 518, 530, 536, 554	2055	1.85	2.0	93			
426, 470, 572, 578, 584, 710, 716, 722, 806	2089	1.82	2.0	91			
226, 323, 371, 377, 464, 644, 680, 686, 1275	2141	1.82	2.0	91			
422, 620, 746, 788, 812, 924, 936, 1026, 1242	2156	1.94	2.0	97			
668, 674, 776, 836, 888, 906, 930, 960, 1050	2174	1.90	2.0	95			
467, 602, 662, 740, 764, 782, 918, 1230, 1236	2185	1.68	2.0	84			
794, 954, 1014, 1170, 1194, 1200, 1218, 1224, 1278	2246	1.77	2.0	89			
229, 272, 284, 290, 326, 380, 1080, 1206, 1248	2265	1.88	2.0	94			
590, 608, 692, 728, 830, 842, 864, 876, 912, 1272	2282	1.61	2.0	80			
413, 527, 533, 966, 978, 990, 996, 1038, 1074, 1086	2294	1.61	2.0	81			
752, 758, 800, 824, 852, 942, 972, 984, 1002, 1207	2316	1.79	2.0	90			
488, 560, 596, 698, 704, 770, 894, 1056, 1062, 1068	2328	1.92	2.0	97			
160, 245, 275, 311, 614, 632, 638, 650, 734, 818	2343	1.47	2.0	74			
858, 870, 882, 1008	2352	1.50	2.0	75			

Table 2. Continuing Quality Control Data for the 2015 Bentazon 1989 Well Water Project: Blank Matrix Spikes.

Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: CDFA
 Chemist: Duc Tran
 Date: 3/29/89

Extraction Set #	Lab Sample #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
1020, 1032, 1044, 1271							
67, 335, 368, 407, 476, 548, 1203, 1209, 1233, 1276	2406	2.03	2.0	102			
242, 302, 338, 386, 410, 416, 551, 815, 927, 939	2423	2.10	2.0	105			
797, 981, 993, 999, 1029, 1041, 1054, 1077, 1083, 1173	2436	1.79	2.0	90			
832, 455, 515,	2469	1.72	2.0	86			
64, 239, 299, 365, 374, 389, 392, 599, 683, 737	2481	1.47	2.0	73			
717, 719, 761, 821, 833, 855, 945, 975, 1059, 1065	2499	1.76	2.0	88			
795, 899, 947, 1081, 1097, 1109, 1171, 1259, 1265, 1274	2539	2.06	2.0	103			
1115, 1133, 1181, 1187	2540	1.93	2.0	97			
OVERALL :					90	8.9	9.9

Table 3. Continuing Quality Control Data for the Z015 Bentazon 1989 Well Water Project : Blank Matrix Spikes.

Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: Cal Labs
 Chemist: Kris Murbach
 Date: 3/29/89

Extraction Set #	Lab Ticket #	Results (ppb)	Spike Level (ppb)	Recovery %	X	SD	CV (%)
7, 8, 11, 13, 14, 17, 19, 20, 23, 25, - 7, 31, 32, 35, 37, 38, 41, 43, 44, 47	45990	8.72 8.20	10.0 10.0	87 82	85	3.5	4.2
51, 57, 69, 75, 81, 87, 93, 105, 117, 123, 129, 135, 141, 147, 153, 164, 171, 177, 183, 195, 201, 207, 213, 219	45443	3.10 3.45	10.0 10.0	31 34	33	2.1	6.5
52, 55, 58, 61, 70, 73, 76, 79, 82, 86, 88, 91, 94, 106, 109, 118, 121, 124, 127, 130, 133, 136, 139, 142, 145, 148, 151, 157, 165, 168, 172, 175, 178, 181, 184, 187, 196, 199, 202, 205, 208, 211, 214, 217, 220, 223	45444	8.08 0.10 0.10 7.92 6.11 7.12 0.48 0.52	10.0 0.2 0.2 10.0 10.0 10.0 0.5 0.5	81 48 49 79 61 71 96 103	74	20	28
516, 522, 527, 563, 575, 581, 593, 636, 653, 659, 683	45575	0.62	0.5	123			
63, 99, 111, 189, 225, 232, 238, 250, 262, 268, 280, 286, 292, 298, 304, 316, 322, 328	45658	0.45 0.41	0.5 0.5	90 81	86	6.4	7.4
334, 340, 346, 352, 358, 364, 370, 376, 382, 388, 394, 400, 406, 424, 451, 457, 463, 469, 475, 481, 493, 499, 505, 511, 517, 523, 529, 535, 541, 547, 553, 565	45658	3.44 2.65 8.58	5.0 5.0 10.0	69 53 86	69	17	24
412, 419, 423, 589, 607, 619, 691, 697, 703, 727, 745, 751, 757, 763	45818	7.04	10.0	70			
769, 787, 811, 823, 829, 835, 841 851,	45818	0.36 5.60	0.5 10.0	72 56	64	11	18

Table 3. Continuing Quality Control Data for the Z015 Bentazon 1989 Well Water Project : Blank Matrix Spikes.

Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: Cal Labs
 Chemist: Kris Murbach
 Date: 3/29/89

Extraction Set #	Lab Ticket #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
863, 875, 887, 893, 905, 911							
923, 929, 935, 941, 959, 965, 971, 977, 983, 989, 995, 1001, 1037, 1049	45818	8.46	10.0	85			
1055, 1061, 1067, 1073, 1085	45818	0.41 10.79	0.5 10.0	82 108	95	18	19
793, 799, 1013, 1025	45843	5.73	10.0	57			
421, 571, 577, 583, 643, 679, 685, 709, 715, 721, 805, 1229, 1241	45860	8.92	10.0	89			
159, 244, 274, 310, 487, 595, 613, 631, 637, 649, 733, 857, 869, 817, 881, 1007, 1019, 1031, 1043, 1199, 1205, 1273	45903	0.35 6.96	0.5 10.0	70 70	70	0	0
OVERALL :					74	21	28

Table 4. Method Validation Blank Matrix Spikes (% Recovery) for the Z015 Bentazon
1989 Well Water Project: MCPA.

Analyte: MCPA
Matrix: D.I. Water
Detection limit: 0.1 ppb

Lab: CDFA
Chemist: Karen Hefner
Date: 04/13/89

Lab Sample #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
2678	0.87	1	87			
2677	0.85	1	85			
2699	0.80	1	80	84	3.6	4.3
2680	1.69	2	84			
2679	1.96	2	98	91	9.9	11
2581	8.45	10.0	85			
2582	9.47	10.0	95			
2696	8.07	10.0	81			
2697	8.46	10.0	85			
2698	9.52	10.0	95	88	6.4	7.3
OVERALL:				88	6.3	7.2

Table 5. Continuing Quality Control Data for the Z015 Bentazon 1989 Well Water Project: MCPA.

Analyte: MCPA
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Lab: CDFA
 Chemist: Karen Hefner
 Date: 04/13/89

Extraction Set #	Lab Sample #	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV (%)
301, 337, 348,	2596	0.73	1.0	73			
373, 379, 391,	2597	0.76	1.0	76			
483, 1075,							
1082, 1087							
66, 113, 241,	2612	0.56	1.0	56			
264, 294, 402,	2611	sample lost	1.0	0			
414, 465, 501,							
591, 789, 796,							
813, 843, 907,							
937, 961, 979							
925, 967, 985,	2637	0.79	1.0	79			
1051, 1057,	2638	0.86	1.0	86	62	32	52
1069							

Table 6. Blind Spike Results for the Z015 Bentazon 1989 Well Water Project.

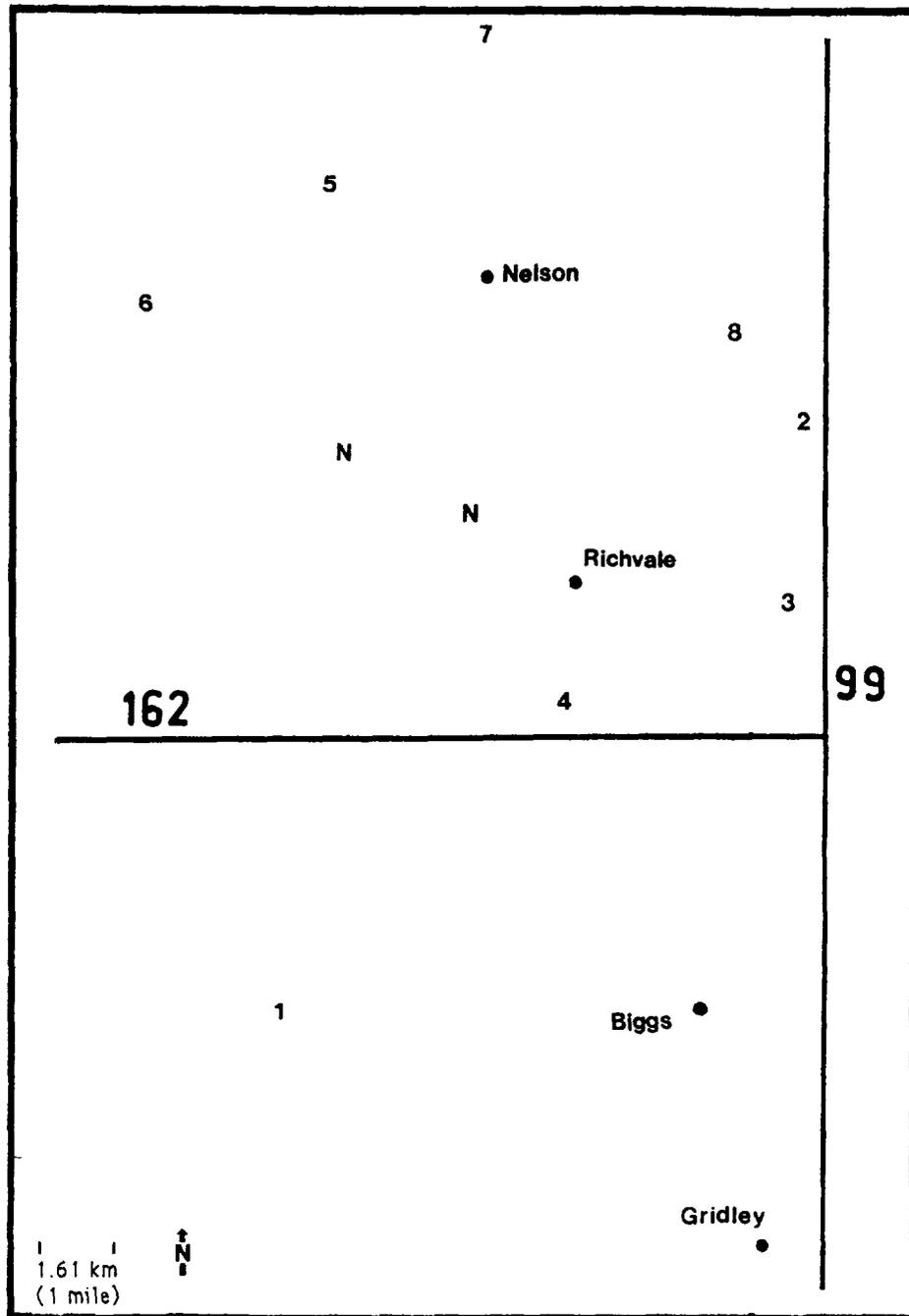
Analyte: Bentazon
 Matrix: D.I. Water
 Detection limit: 0.1 ppb

Labs: CAL=Enseco California Analytical
 CDFA=California Department of Food and Agr.
 EMA=Environmental Micro-Analysis
 Date: 4/13/89

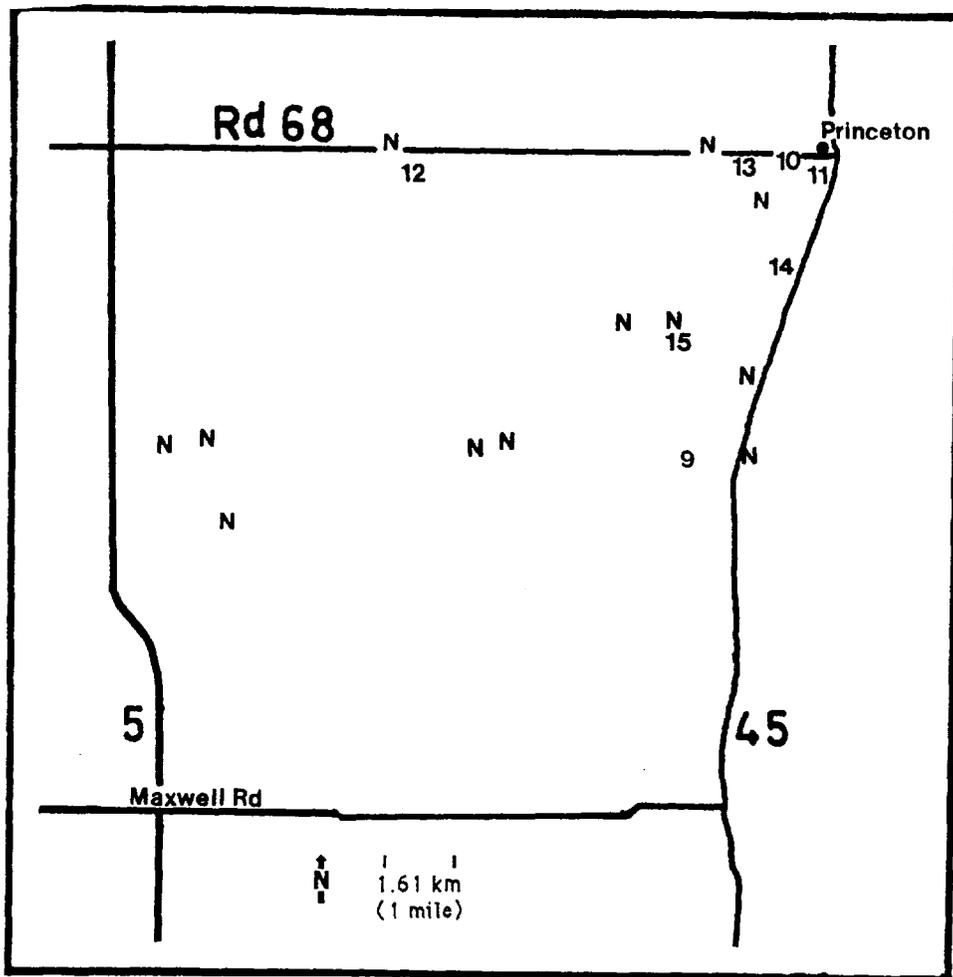
EHAP #	Lab	Date Prepared	Date Extracted	Results (ppb)	Spike Level (ppb)	Recovery %	\bar{X}	SD	CV %
25	CAL	12/20/88	12/27/88	3.16	3	105			
26	CAL	12/20/88	12/27/88	2.53	3	84			
421	CAL	2/16/89	2/23/89	1.3	3	43			
424	CAL	1/9/88	2/9/89	2.06	3	69			
419	CAL	1/9/89	2/17/89	2.8	3	93			
1273	CAL	2/16/89	2/24/89	2.3	3	77	79	21	27
422	CDFA	2/16/89	3/3/89	2.18	3	73			
425	CDFA	1/9/89	2/16/89	2.98	3	99			
1271	CDFA	3/7/89	3/10/89	2.2	2	110			
1272	CDFA	1/9/89	3/8/89	2.2	3	73			
1274	CDFA	2/16/89	3/23/89	2.9	3	97			
1275	CDFA	1/9/89	3/1/89	2.42	3	81			
1276	CDFA	3/7/89	3/14/89	2.15	2	108	91.6	15.8	17.2
418	EMA	1/9/89	2/16/89	0.63	3	21			

APPENDIX III. COUNTY MAPS WITH WELL LOCATIONS

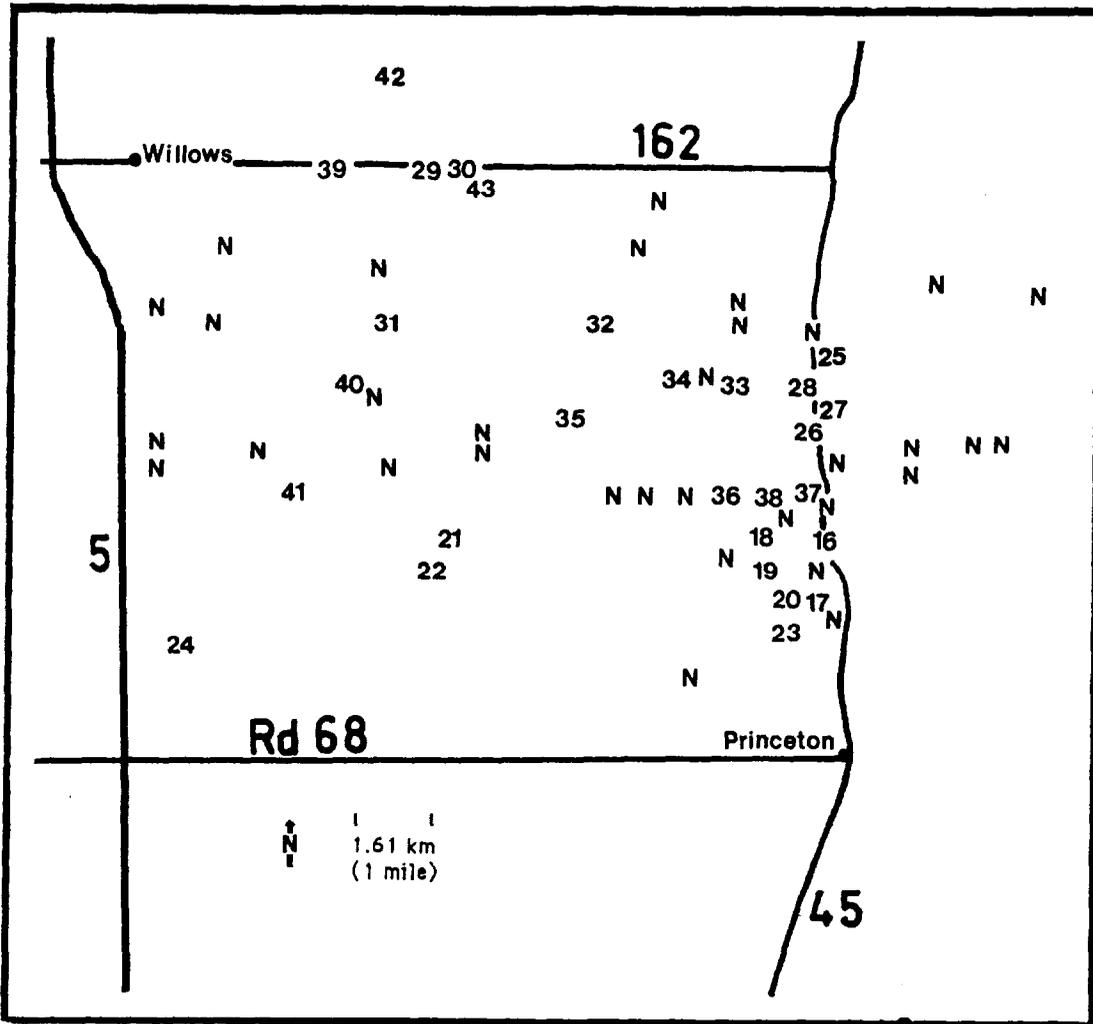
Butte county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



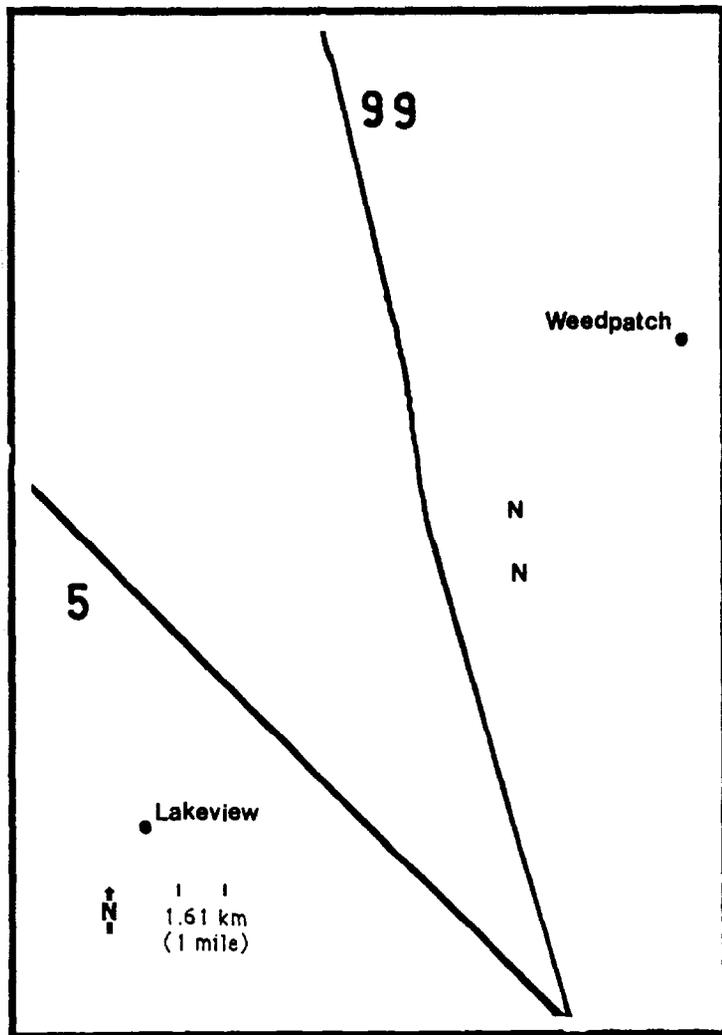
Colusa county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



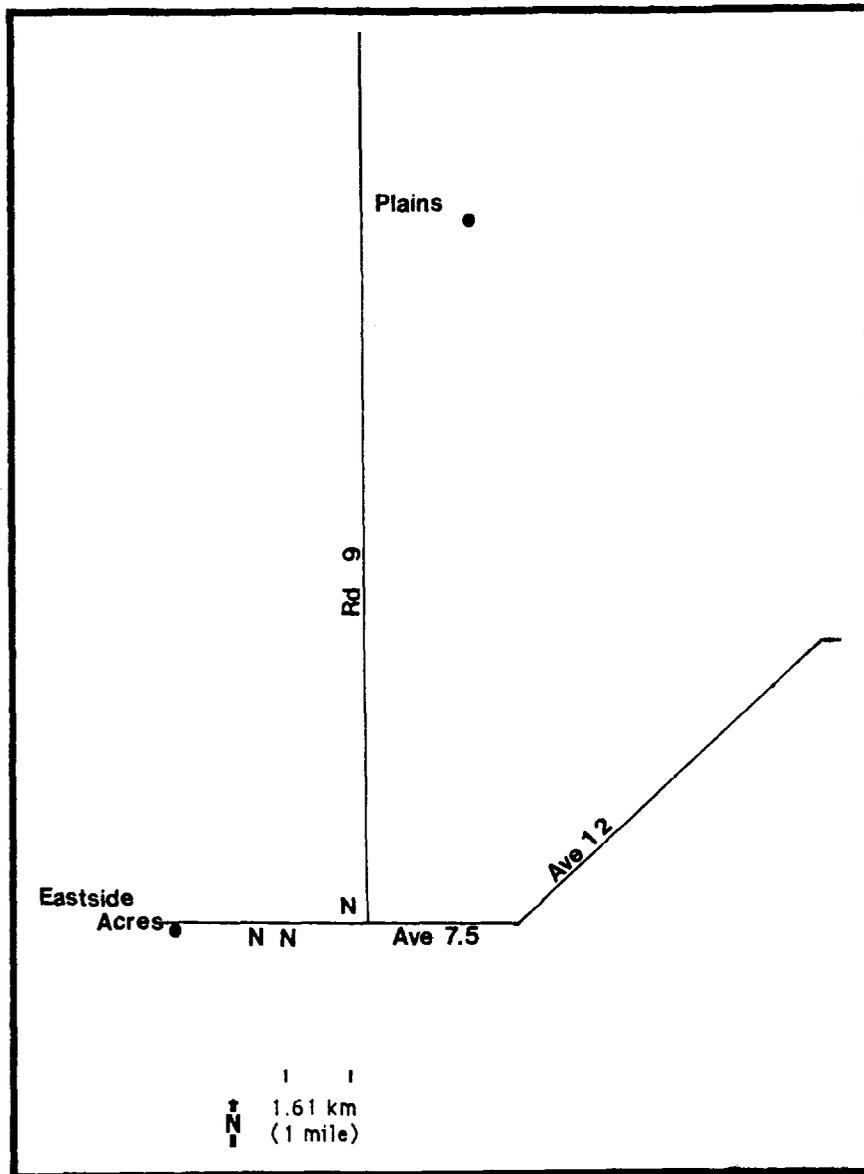
Glenn county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



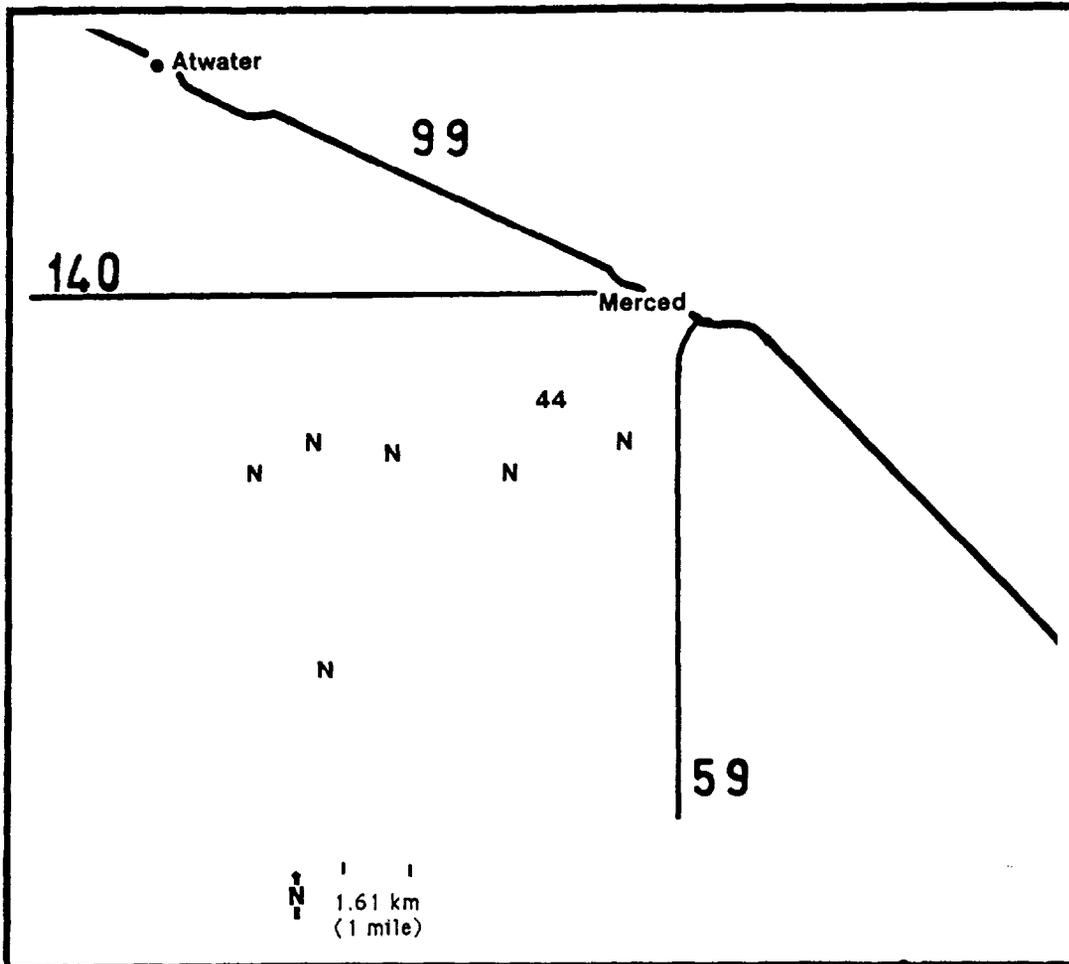
Kern county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



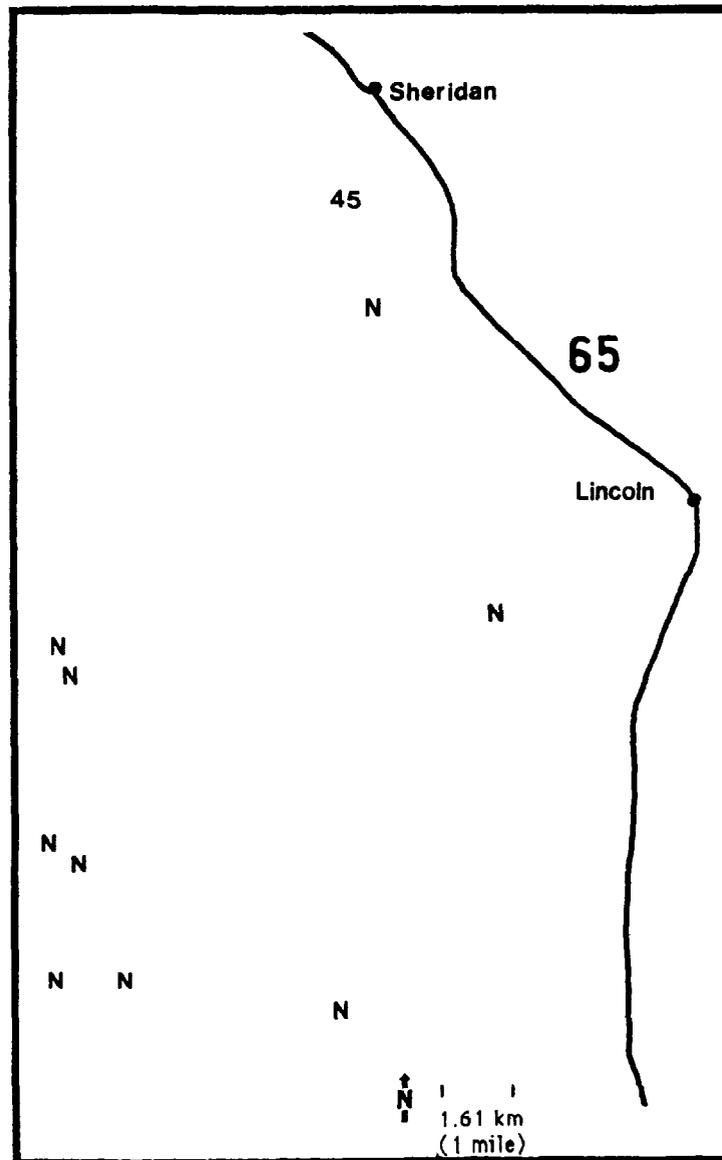
Madera county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



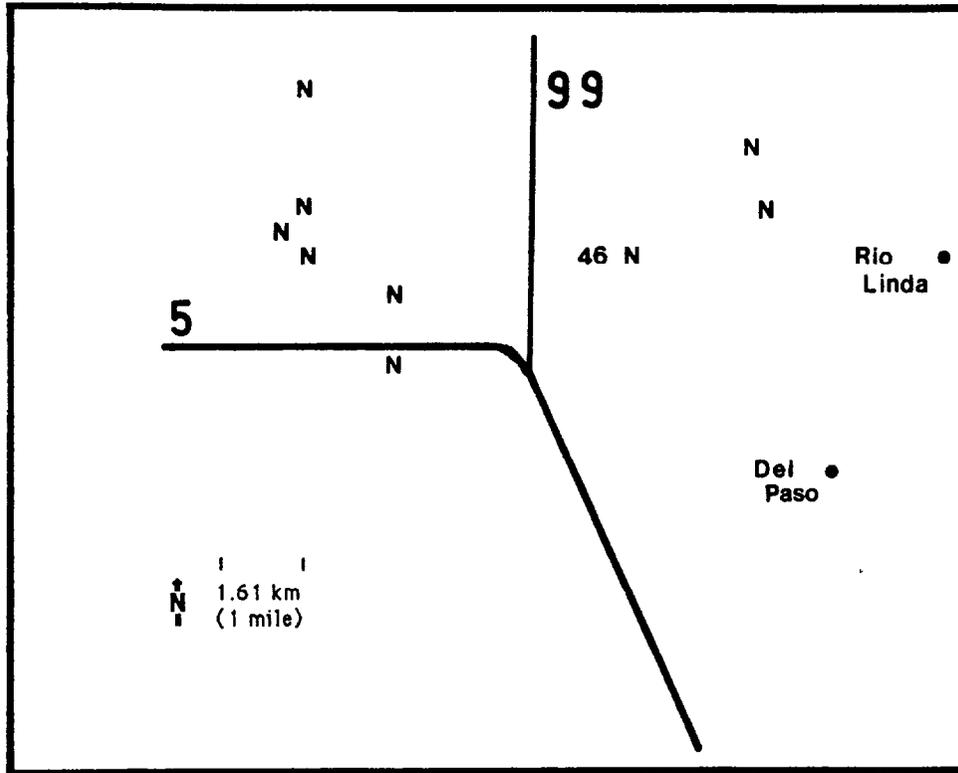
Merced county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



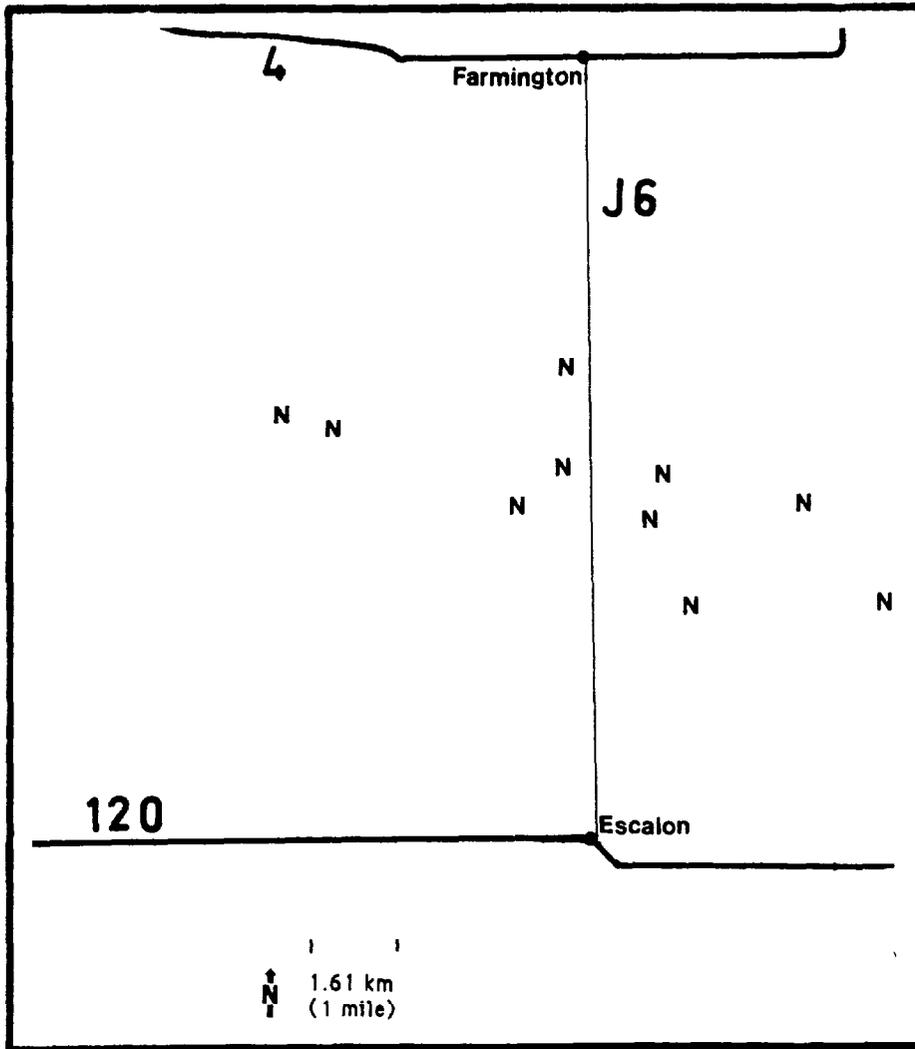
Placer county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



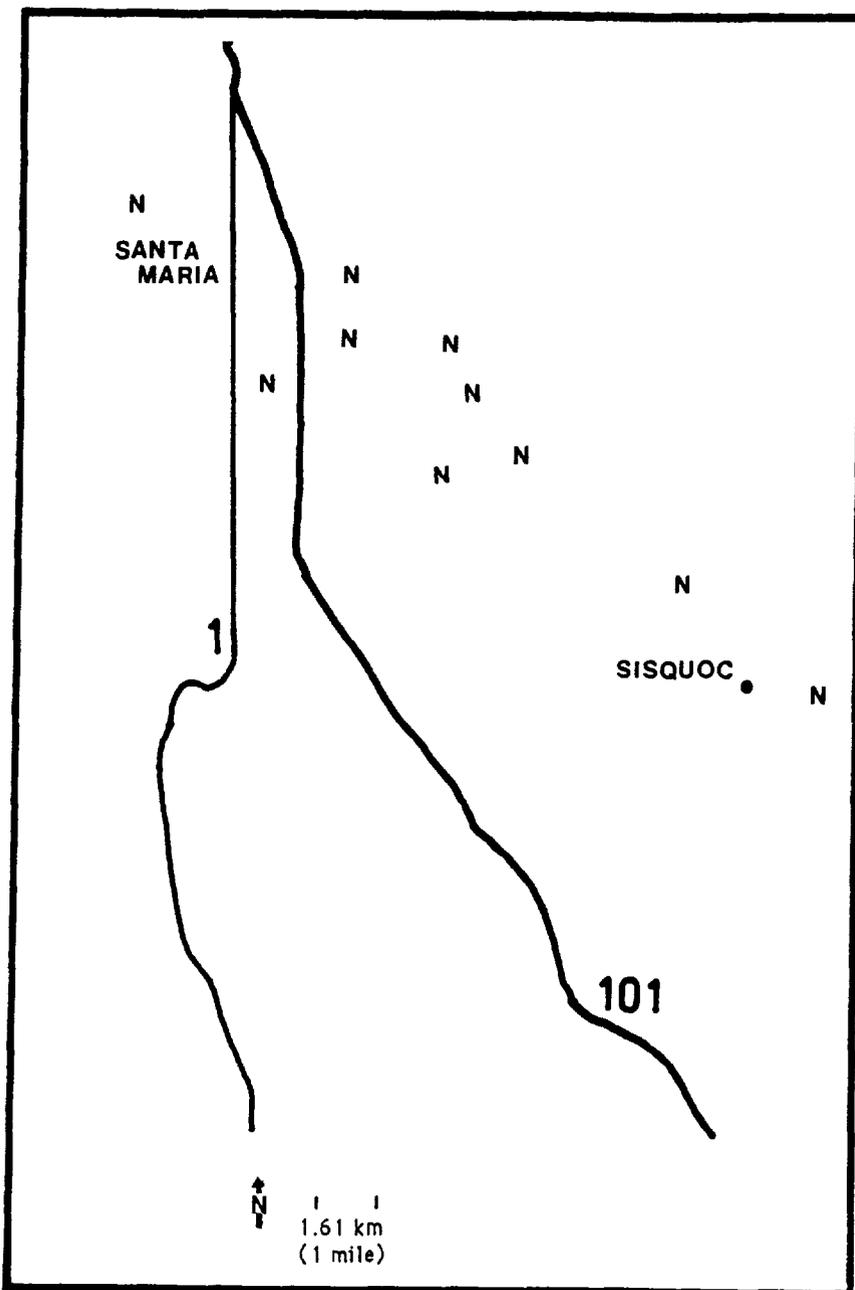
Sacramento county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



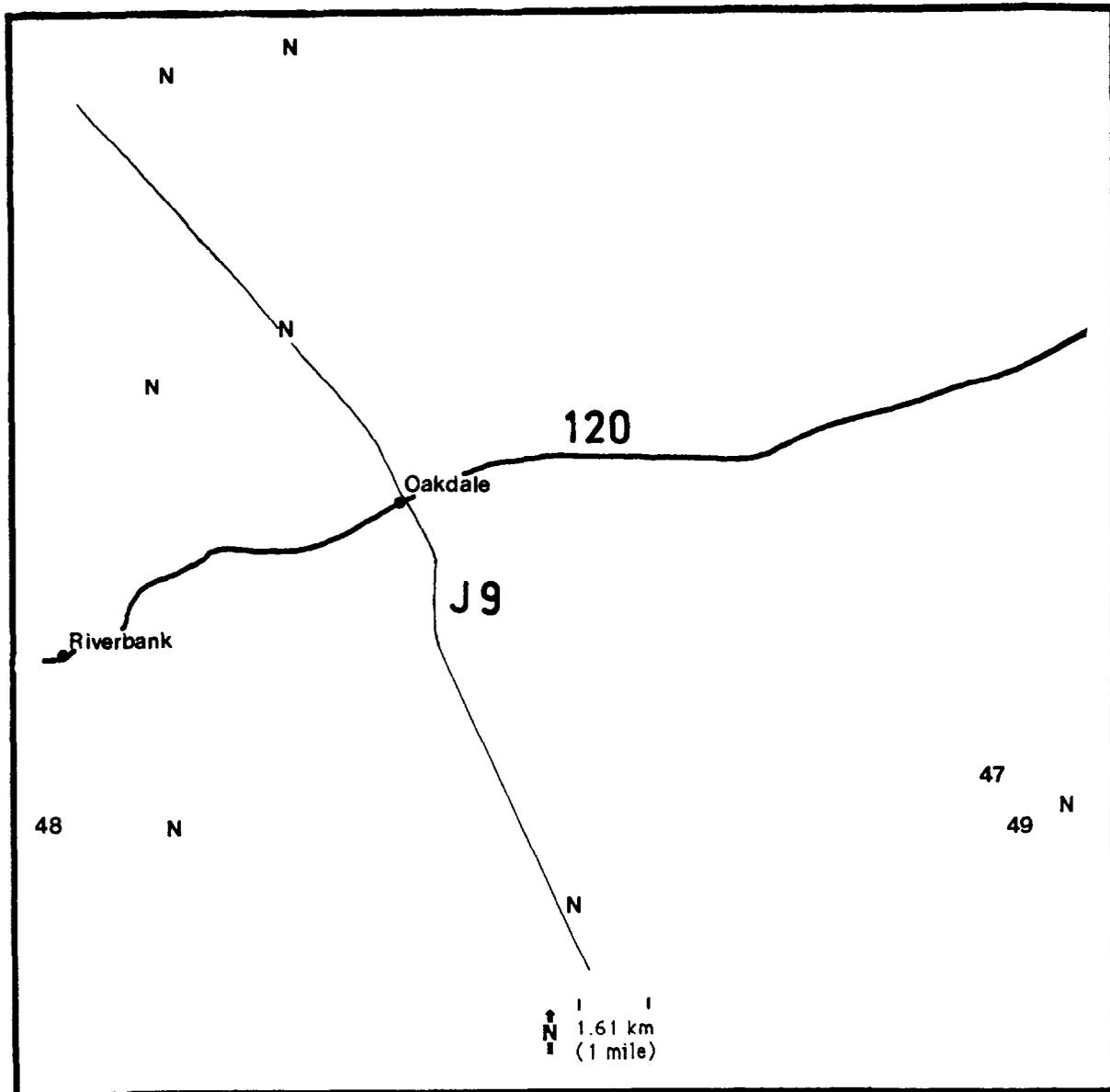
San Joaquin county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



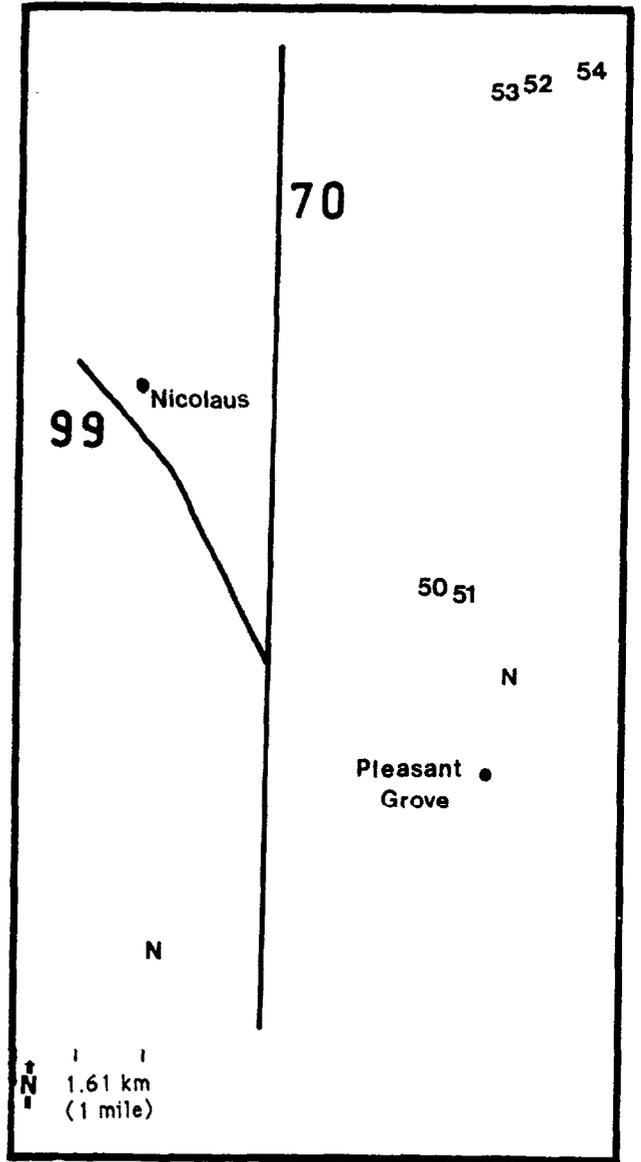
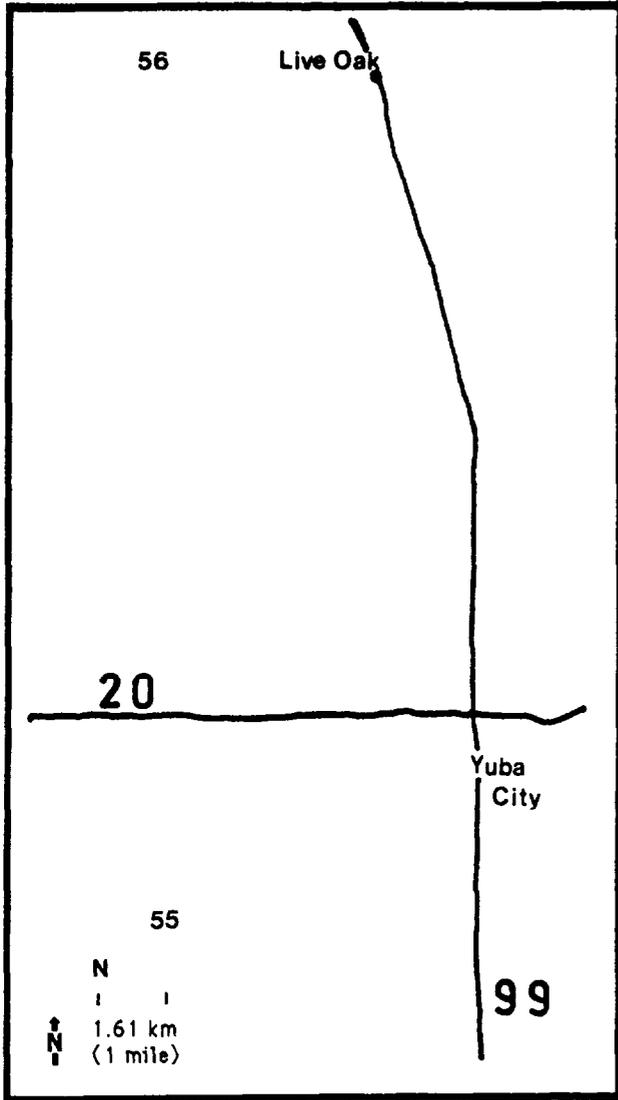
Santa Barbara county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



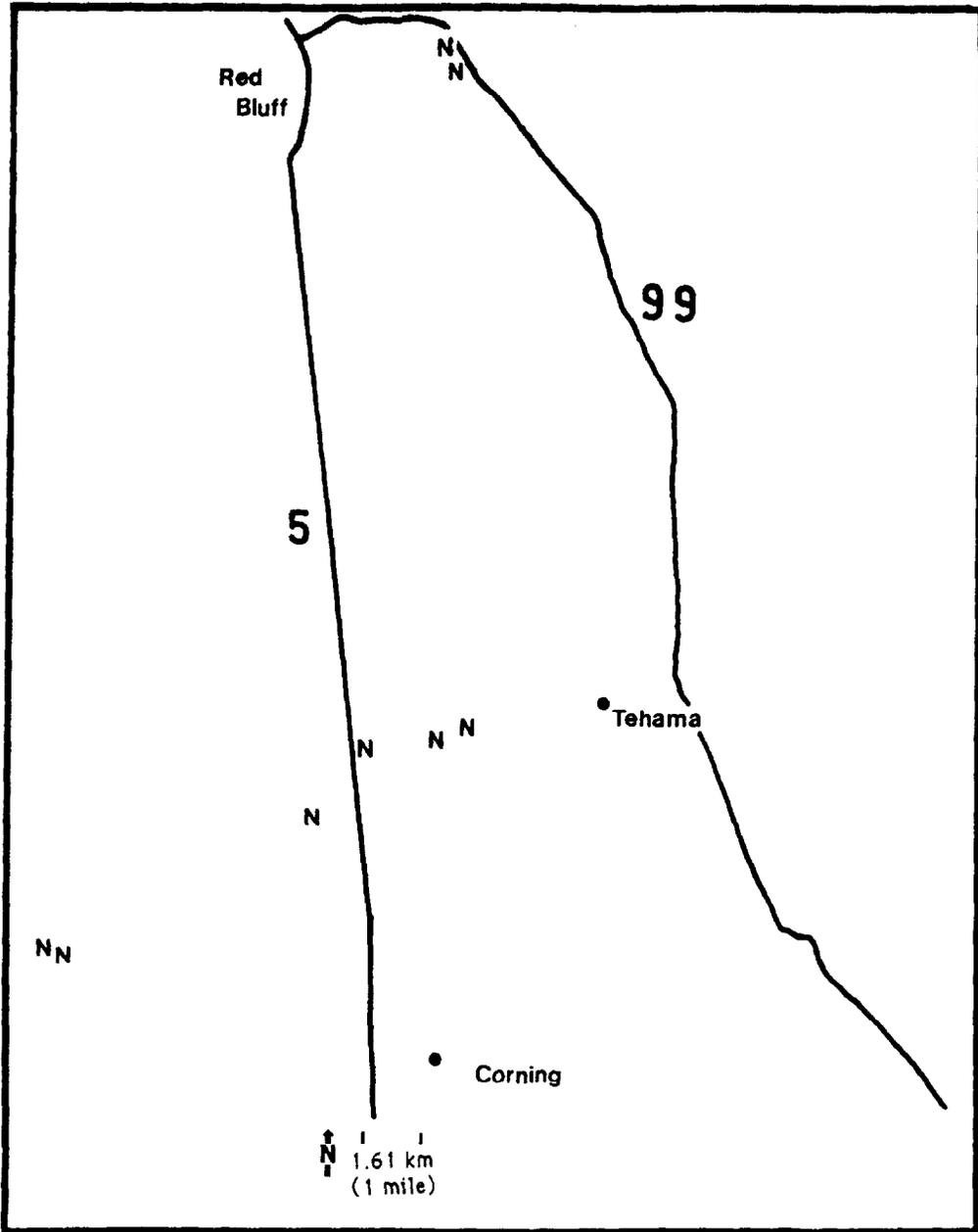
Stanislaus county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



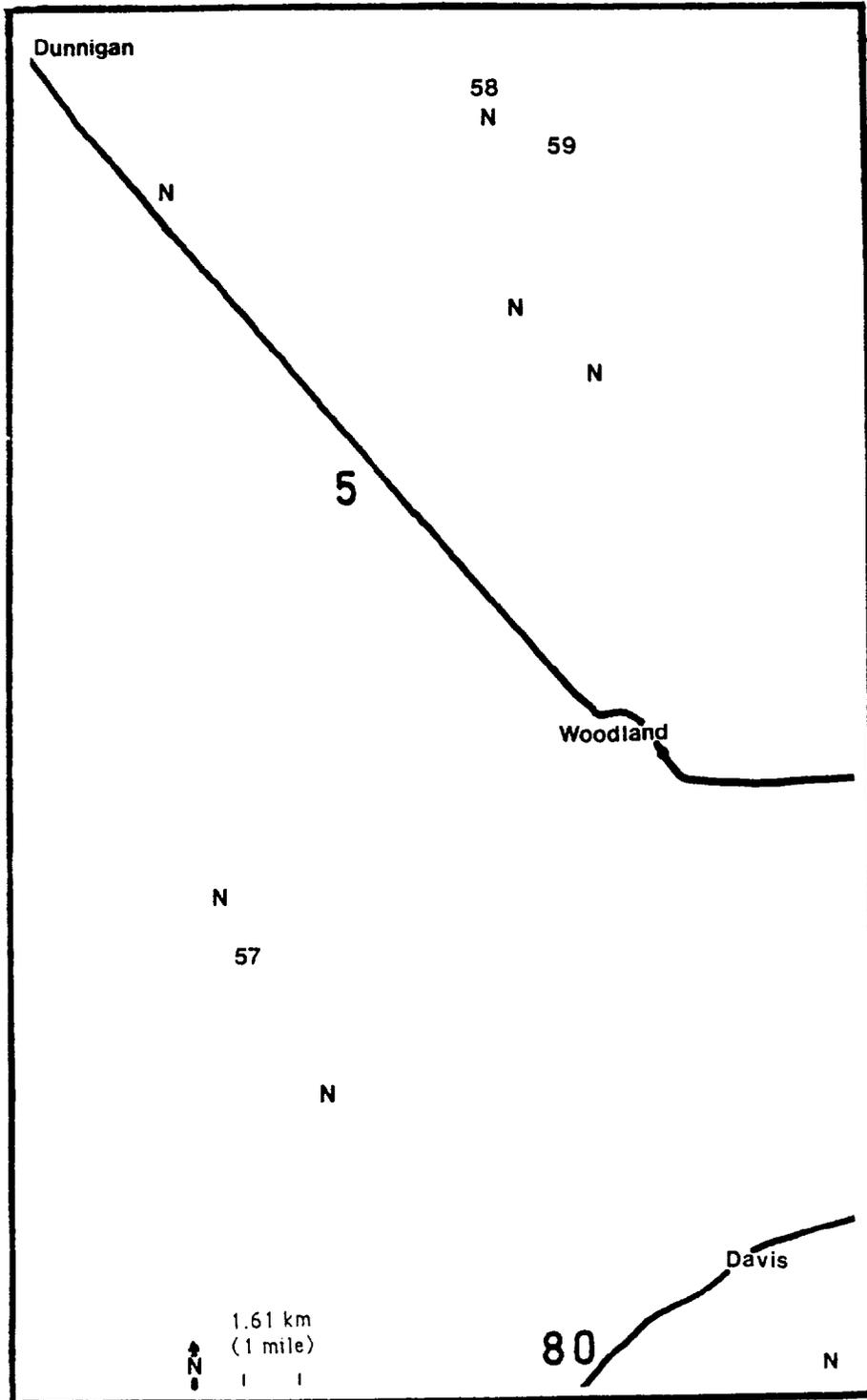
Sutter county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



Tehama county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



Yolo county well locations. Positive wells are represented by a MAP ID number between 1 and 63.



Yuba county well locations. Positive wells are represented by a MAP ID number between 1 and 63.

