

Contract Report 583

**Continued Operation of a Raingage Network
for the Imperial Valley Water Authority
Year Two: September 1993 - August 1994**

**by Randy A. Peppier, Office of Special Programs
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**Prepared for the
Imperial Valley Water Authority**

June 1995

Illinois State Water Survey
Atmospheric Sciences Division
Champaign, Illinois

A Division of the Illinois Department of Energy and Natural Resources

**CONTINUED OPERATION OF A RAINGAGE NETWORK
FOR THE IMPERIAL VALLEY WATER AUTHORITY
YEAR TWO: SEPTEMBER 1993 -AUGUST 1994**

Randy A. Peppier

and

Steven E. Hollinger

REPORT

to

Imperial Valley Water Authority

on Contract

Imperial Valley 223

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June 1995

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**CONTINUED OPERATION OF A RAINGAGE NETWORK
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1. INTRODUCTION

Regional precipitation variability affects irrigation water demand on an aquifer, the recharge of the aquifer, and the density of wells and irrigation systems required for agriculture and water supplies. These factors all impact any required water withdrawal allocations from an aquifer. Therefore, knowledge of the precipitation variability over an extensively irrigated region, such as the area within the Imperial Valley Water Authority (IVWA), should provide useful information for the management of ground-water resources in that region.

At present, the measurement of precipitation is best accomplished by deployment of a network of raingages of sufficient areal density for a long period of time. A relatively dense raingage spacing is needed to capture both summertime convection, which can be quite variable, and more widespread wintertime events. A relatively long time period is necessary to capture short-term climatological shifts such as abnormally wet or dry periods and even normal periods. Such networks provide the data necessary to understand the variability of precipitation patterns both spatially and temporally, and thus the spatial and temporal variations in the recharge of the soil and ground water within the network area. The data help identify the extent of areas susceptible to heavy irrigation water use and/or areas of poor recharge. Combined with ground-water data, these precipitation data can provide the inputs needed for estimates of recharge to the ground-water resources within the network area.

During the last 40 years, the Illinois State Water Survey (ISWS) has operated raingage networks of varying areal gage densities over various time periods in both rural and urban areas. Sampling requirements, as determined from these past studies (e.g., Huff, 1970), indicate that a 2- to 3-mile gridded raingage spacing should be adequate for properly capturing convective precipitation systems (spring and summer), while a 6-mile spacing is adequate for more widespread precipitation-producing systems (fall and winter). Compromises within these ranges are acceptable in a rural setting. The weighing-bucket raingage, used by the National Weather Service, provides precise and reliable precipitation measurements. Given the size of the IVWA area and the above spacing guidelines, a gridded, 25-site raingage network with approximately 5 miles between gages was proposed.

The ISWS itself has a long-term interest in precipitation measurement and related research, and has performed precipitation research in areas such as hydrology, weather modification, and urban influences on precipitation climate. The data collected by a raingage network such as the IVWA Network would be used in similar research.

An agreement was reached between the IVWA and the ISWS in spring 1992, and the 25-site network was deployed in late August 1992. Results of the first year of network operation (September 1992 through August 1993) are contained in Peppier and Hollinger (1994), while this report documents the operation, maintenance, data reduction, and management of the network during its second year of operation (September 1993 through August 1994). This report also provides data analyses for the year. Several appendices

document the actual raingage sites, instructions for raingage technicians, raingage maintenance, unusually large precipitation amounts recorded during the year, and monthly precipitation variability at each of the sites.

2. NETWORK DESIGN

Figure 1 shows the layout of the raingage network as designed in summer 1992. Descriptions of construction of the IVWA Network and the type and setup of the weighing-bucket raingages used to collect precipitation are given in Peppier and Hollinger (1994). Appendix I gives complete site description information for each network raingage location as of August 31, 1994.

3. NETWORK OPERATION AND MAINTENANCE

During the second year of operation, local observers continued to perform weekly raingage maintenance at 11 sites, while the other 14 raingages were handled by a retired ISWS scientist living in Champaign. Each raingage was serviced every 6 to 11 days. Servicing included removing and replacing the current chart, checking the felt-tipped pen to make sure it is inking properly, dumping the bucket contents from approximately April through October, and noting any unusual problems, including chart-drive malfunction, gage imbalance or instability, vandalism, unauthorized movement of the gage, etc. During the warm season, evaporation shields were fitted into the collection orifice above the bucket to minimize evaporation. During the cold season, a 1-quart charge of antifreeze was added to each raingage bucket so that any frozen precipitation collected would be melted to allow a proper weight reading. Approximately once a week the local observers and the ISWS scientist mailed and/or delivered a complete set of 25 charts to the ISWS. Refer to Appendix II for a complete description of servicing instructions for raingage observers.

As needed, the Champaign-based scientist visited the network to perform maintenance and repairs. This usually consisted of a site assessment of an observer-noted problem and the determination of a solution. Because most problems pertained to the chart drives, the usual solution was to adjust or replace the chart drive. If replaced, the defective chart drive was cleaned and readied for reuse at the ISWS. Other typical problems, mentioned above, were also solved on these trips. Appendix HI gives a complete maintenance history, including site relocations, for each of the 25 raingages, and more fully describes the kinds of maintenance and repairs conducted. This information is listed through August 31, 1994.

4. DATA REDUCTION

Data reduction activities during Year Two of network operation were identical to those of Year One. Please see Peppier and Hollinger (1994) for complete details on these tasks.

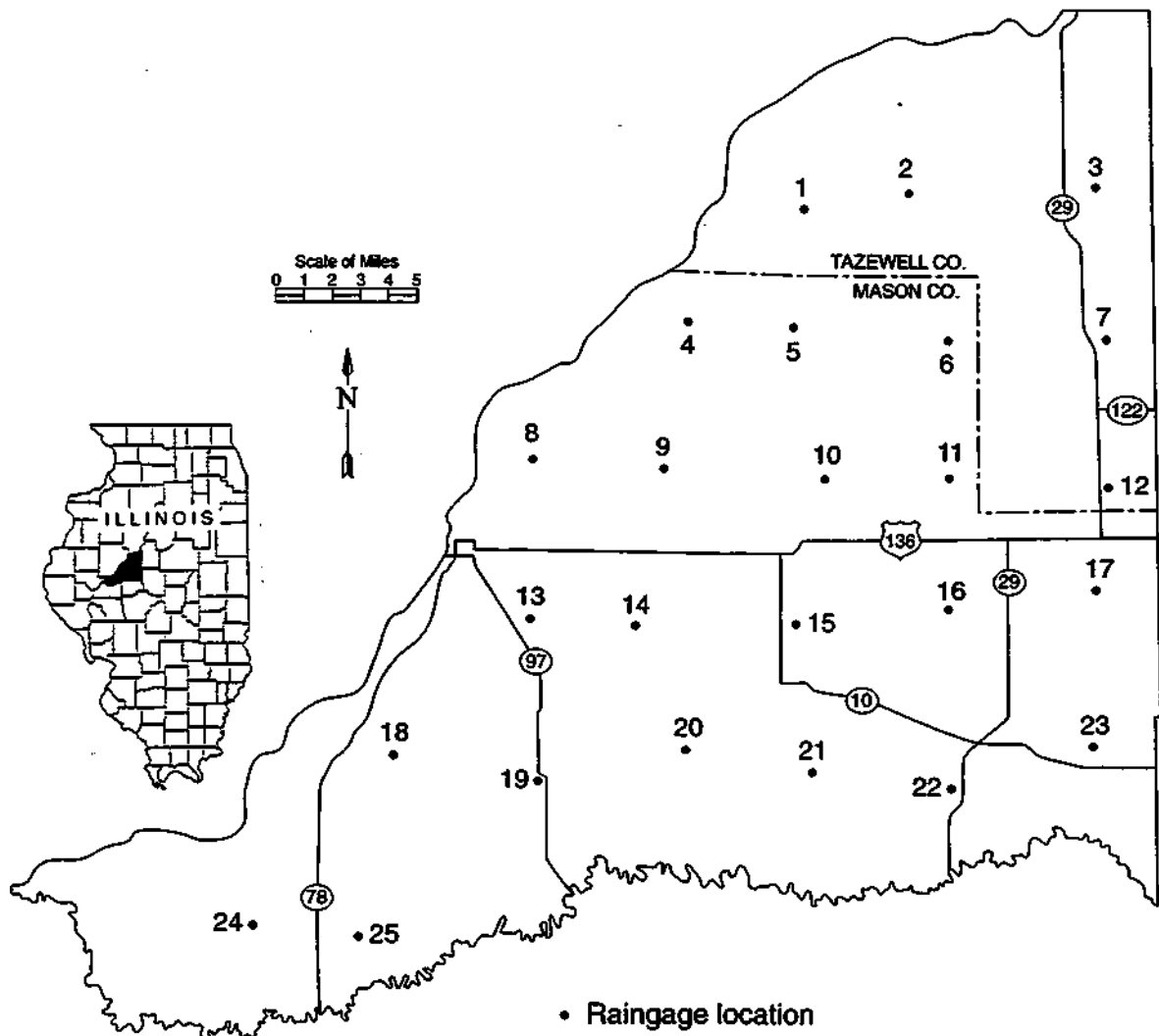


Figure 1. Configuration of the 25-site Imperial Valley Water Authority raingage network

5. DATA ANALYSIS AND METHODOLOGIES

Table 1 contains monthly and annual (September 1993-August 1994) precipitation amounts for each site in the IVWA Network. Corresponding analyses are contained in Figure 2 (annual) and Figures 3-8 (monthly). Figure 9 shows a timeline of average network precipitation during the 12-month period.

Table 1 and Figure 2 show that totals for the year ranged from 49.61 inches at Site #19 just north of Kilbourne to 31.89 inches at Site #8 northeast of Havana. (Site #19 recorded the largest amount of precipitation during the first year of network operation as well.) Fourteen sites reported more than 40 inches for the 12-month period, while the other 11 reported less than 40 inches. The network average was 40.21 inches, much lower than that of the first year (55.55 inches). However, compared to 1961-1990 normal values at the Havana and Mason City National Weather Service cooperative stations (37.24 and 35.08 inches, respectively), the second-year average was still 3 to 5 inches above what would be considered the long-term average for the region.

Annual amounts were largest in the southern half of the network around Site #19 and Site #24 near Snicarte and extending northeastward to Site #10 south of Forest City and then eastward to Site #12 just northwest of San Jose. This region of heavier precipitation includes three heavy cellular areas with somewhat lighter amounts in between, possibly indicating a preferred storm track through the area. There was less precipitation in the northern half of the network around Site #8 and extending northeastward to Site #1 near Spring Lake. Amounts under 40 inches were generally prevalent north of U.S. 136 (except towards the east), while amounts over 40 inches were found south of that route.

Monthly analyses in Figures 3-8 (see Table 1 for specific amounts) show that September 1993 (Figure 3), the first month of the second operational year, was by far the wettest month of that year (11.56-inch network average), followed by April 1994 (Figure 6, 5.03-inch average), August 1994 (Figure 8, 3.66-inch average), July 1994 (Figure 8, 3.44-inch average), June 1994 (Figure 7, 3.19-inch average), and May 1994 (Figure 7, 3.11-inch average). As can be seen, the first month and the last five months were the wettest of Year Two. During all of these months, and particularly in September 1993, the heaviest precipitation tended to occur in the southern half to two-thirds of the network. In April 1994 heavier amounts also occurred in the extreme north in southern Tazewell County.

All other months (October 1993-March 1994, Figures 3-6) averaged less than 3 inches of precipitation across the network. December 1993 through March 1994 were particularly dry, with each month averaging less than about 1.6 inches of precipitation network-wide. January 1994 (Figure 5, 0.96-inch average) and March 1994 (Figure 6, 0.96-inch average) were the two driest months, followed closely by December 1993 (Figure 4, 1.11-inch average) and February 1994 (Figure 5, 1.64-inch average). October 1993 (Figure 3, 2.97-inch average) and November 1993 (Figure 4, 2.59-inch average) were somewhat wetter. This six-month period of relative dryness was much-welcomed after the extremely heavy rains of June-September 1993, and much of the ground-water flooding that occurred in the IVWA area during the summer and early fall of 1993 subsided during this dry period. During these months there did not appear to be any preferred areas of heavy precipitation, but central portions of the network, particularly towards the west, tended to be drier.

Table 1. Monthly and Year Two Precipitation Amounts for September 1993-August 1994 (inches)

Date	Site Number																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Sep 1993	9.51	10.79	11.85	9.36	9.66	12.06	11.34	9.12	11.11	12.23	12.54	12.32	12.20	12.48	13.14	10.76	11.47	12.71	13.00	11.32	10.66	11.22	10.6	13.72	13.80
Oct 1993	3.31	4.02	3.27	3.27	3.17	2.92	3.15	3.12	2.71	2.51	2.69	3.24	2.67	2.54	3.60	2.88	3.22	2.68	3.32	3.33	3.03	2.85	3.05	1.82	1.78
Nov 1993	2.35	2.54	2.58	2.40	2.28	2.47	2.35	2.43	2.42	2.44	2.36	2.53	2.72	2.53	2.44	2.60	2.82	2.66	2.87	2.48	2.74	2.97	2.94	3.09	2.74
Dec 1993	1.34	1.55	0.95	1.01	1.03	0.76	1.13	0.86	1.01	1.01	1.19	1.06	0.92	1.00	0.92	1.14	1.10	1.06	1.41	1.03	1.01	1.34	1.62	1.15	1.04
Jan 1994	0.81	0.67	0.97	0.51	0.75	0.84	1.24	0.58	1.00	0.89	1.11	1.19	0.94	0.92	1.02	1.07	1.40	0.63	1.13	0.92	1.06	1.06	1.10	1.09	1.06
Feb 1994	1.56	1.58	1.82	1.44	1.75	1.62	1.41	1.36	1.89	1.87	1.55	1.38	1.76	2.00	1.65	1.41	1.54	1.51	1.87	1.80	1.40	1.63	1.39	1.69	2.02
Mar 1994	0.73	0.86	0.90	0.80	0.83	0.90	1.09	0.65	0.85	1.04	1.05	0.97	0.89	0.80	0.98	1.05	1.04	1.08	1.13	0.94	0.97	1.12	1.04	1.17	1.19
Apr 1994	4.72	5.85	4.68	4.46	4.47	4.12	4.68	4.42	4.62	4.73	4.72	5.22	4.51	4.45	4.93	5.29	5.02	5.32	6.19	5.17	5.02	5.57	5.00	6.23	6.42
May 1994	2.39	3.31	2.96	3.25	3.13	3.14	2.90	2.89	2.82	3.32	3.18	3.88	3.19	2.57	3.22	2.86	3.56	2.46	3.44	2.79	2.29	2.36	2.82	4.93	3.98
Jun 1994	1.79	1.59	2.09	2.04	2.38	2.09	1.95	2.28	3.15	4.03	2.49	2.51	3.63	5.26	4.23	3.42	2.88	3.63	4.47	5.03	3.94	3.94	3.59	3.76	3.46
Jul 1994	3.23	3.40	2.60	2.80	3.42	4.43	3.43	1.86	2.30	4.52	4.40	4.28	3.66	3.09	2.25	3.50	4.29	4.23	5.74	2.96	2.10	2.01	3.76	3.52	4.22
Aug 1994	2.83	2.64	3.55	3.63	3.62	3.63	3.42	2.32	2.84	4.06	3.59	3.69	3.83	3.46	3.33	3.79	3.47	5.15	5.04	4.08	3.37	4.02	3.48	4.73	4.04
Year Two	34.57	38.80	38.22	34.97	36.49	38.98	38.09	31.89	36.72	42.65	40.87	42.27	40.92	41.10	41.71	39.77	41.81	43.12	49.61	41.85	37.59	40.09	40.46	46.90	45.75

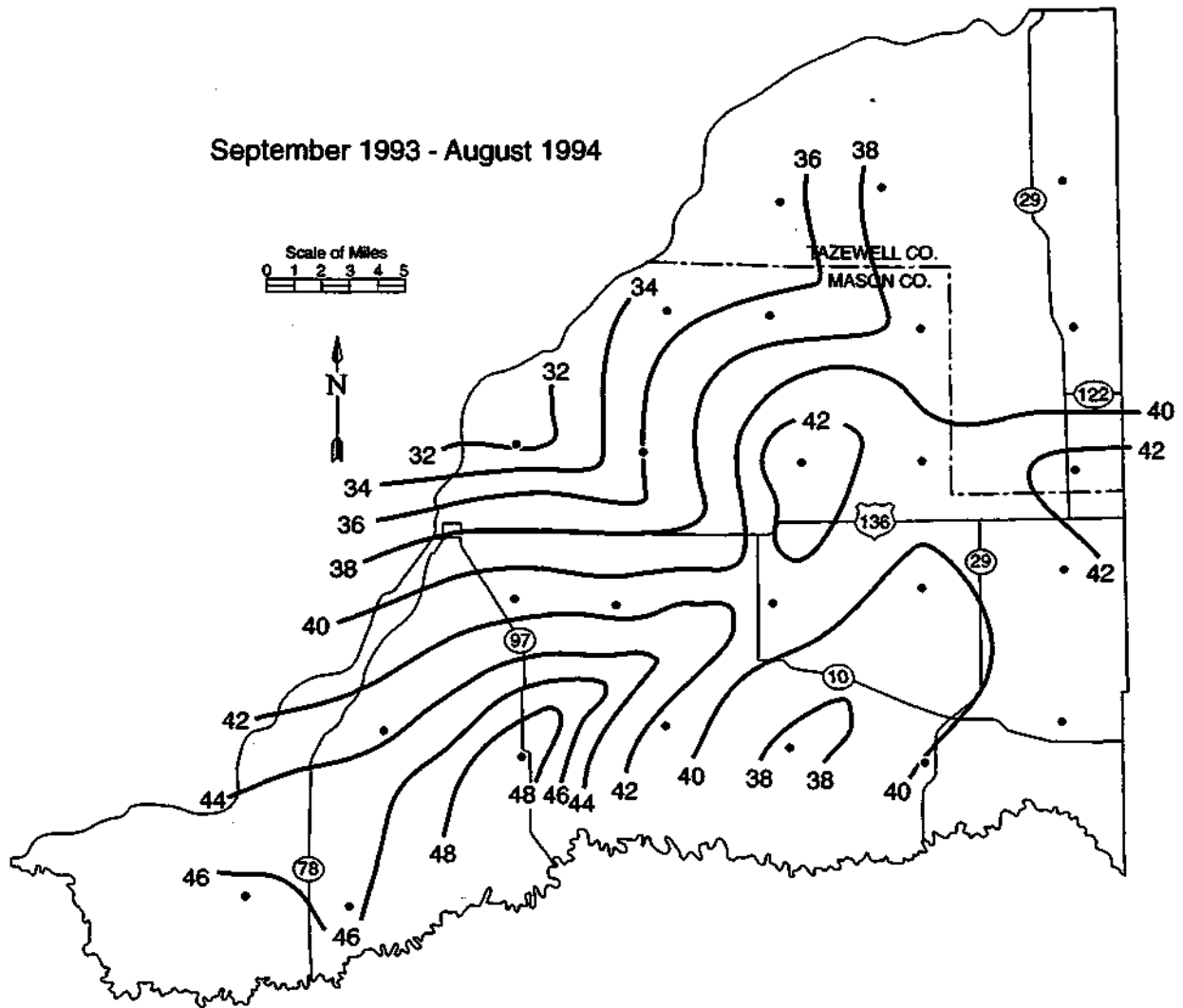


Figure 2. Precipitation pattern (inches) for September 1993-August 1994

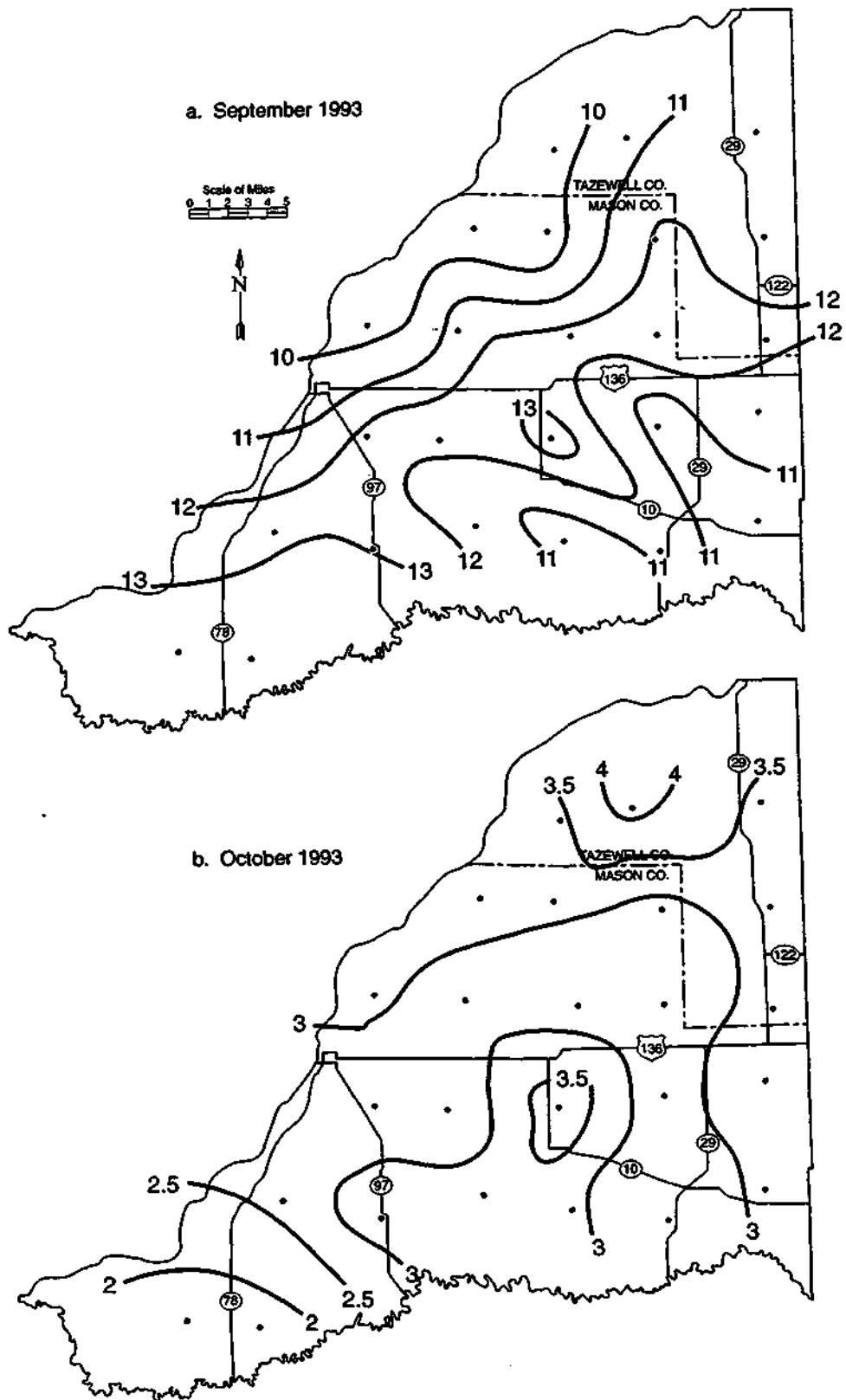


Figure 3. Precipitation pattern (inches) for September 1993 (a), October 1993 (b)

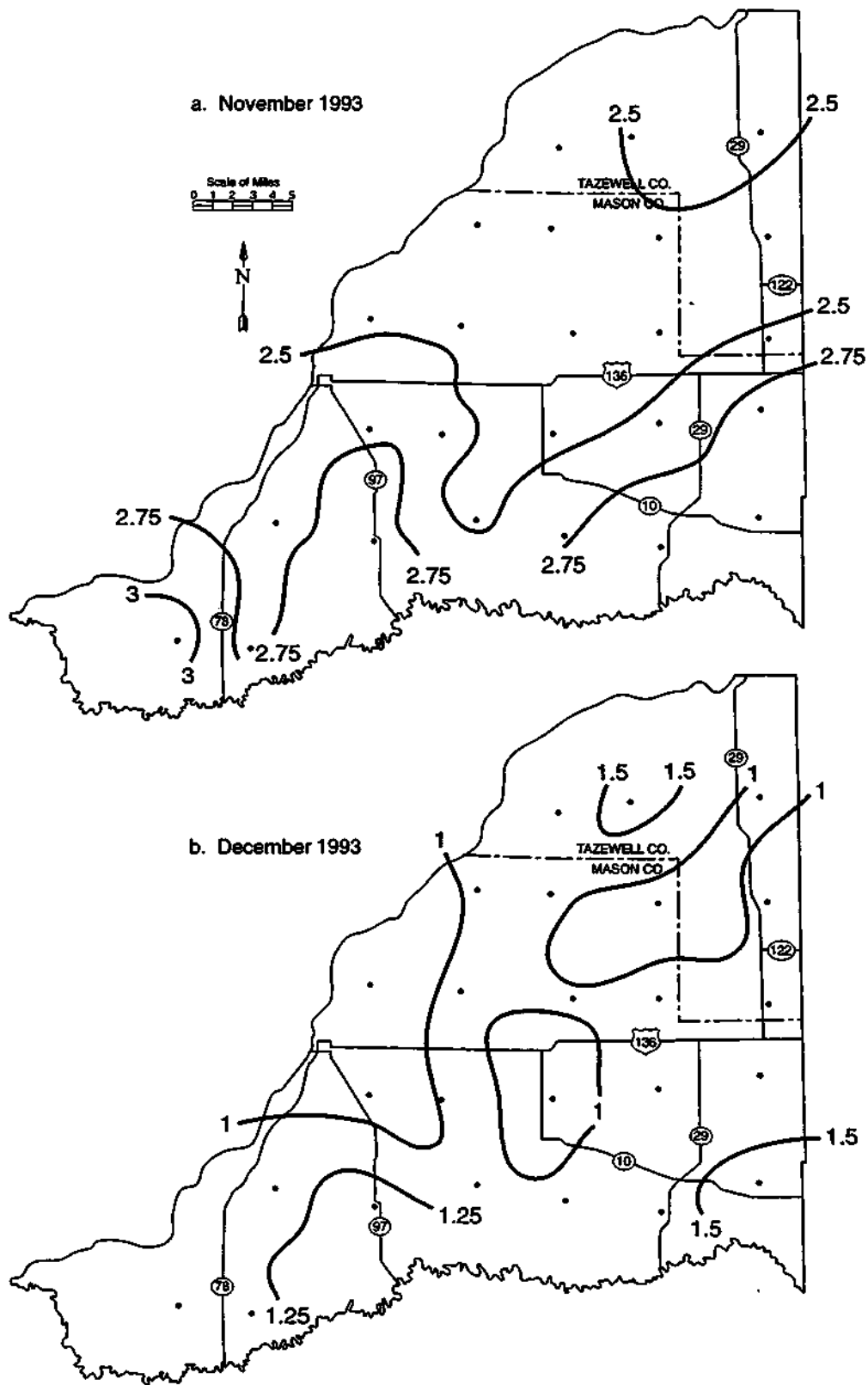


Figure 4. Precipitation pattern (inches) for November 1993 (a), December 1993 (b)

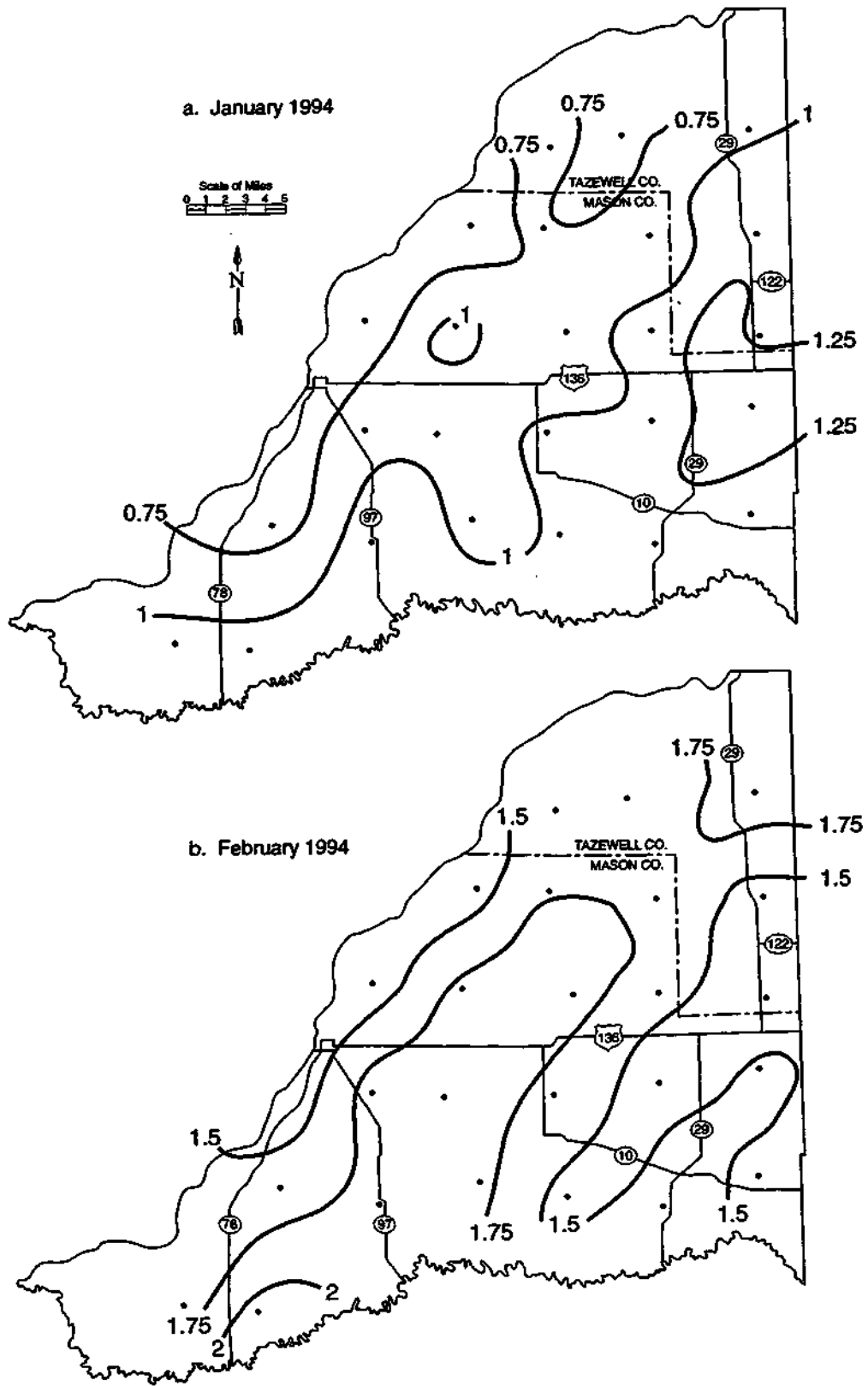


Figure 5. Precipitation pattern (inches) for January 1994 (a), February 1994 (b)

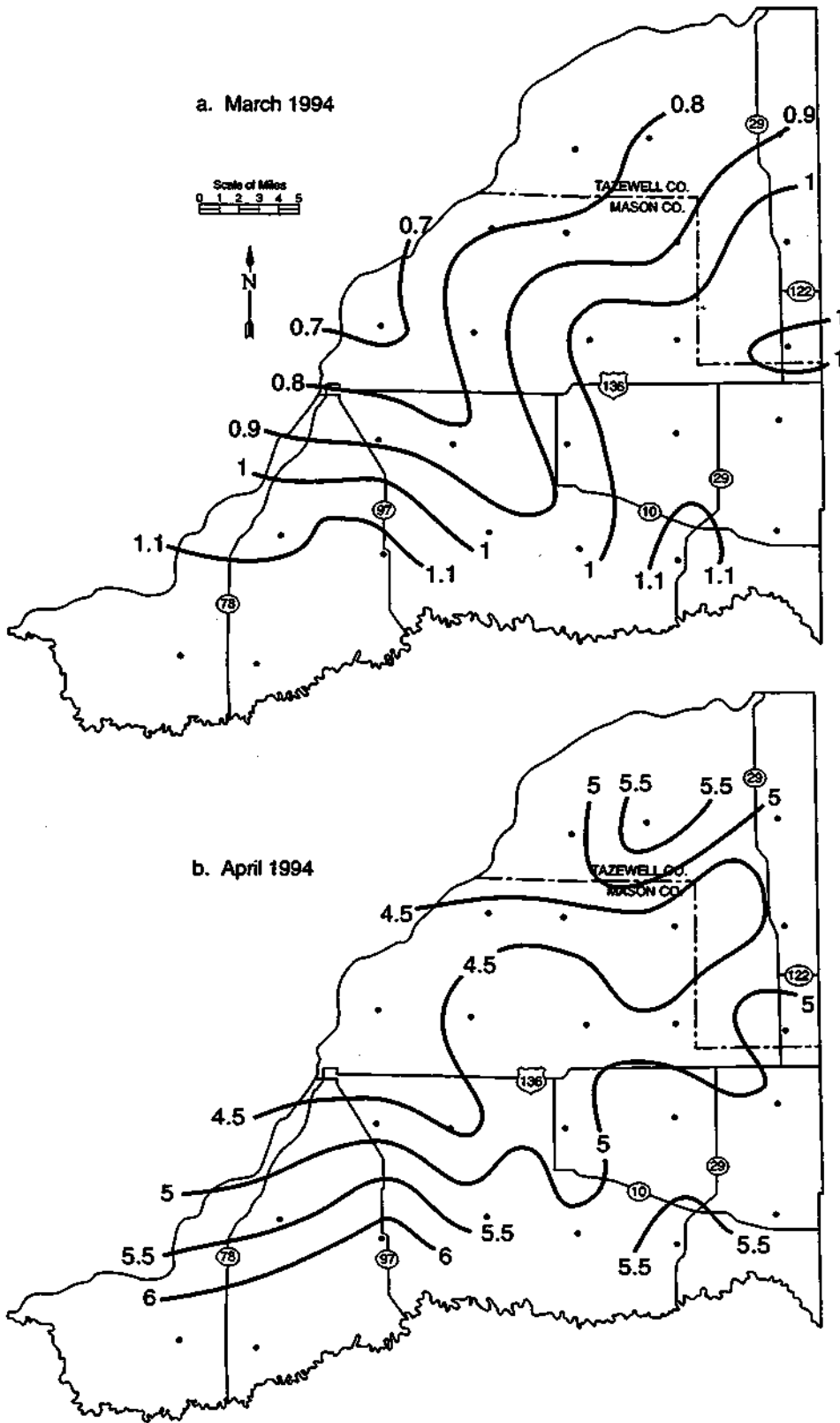


Figure 6. Precipitation pattern (inches) for March 1994 (a), April 1994 (b)

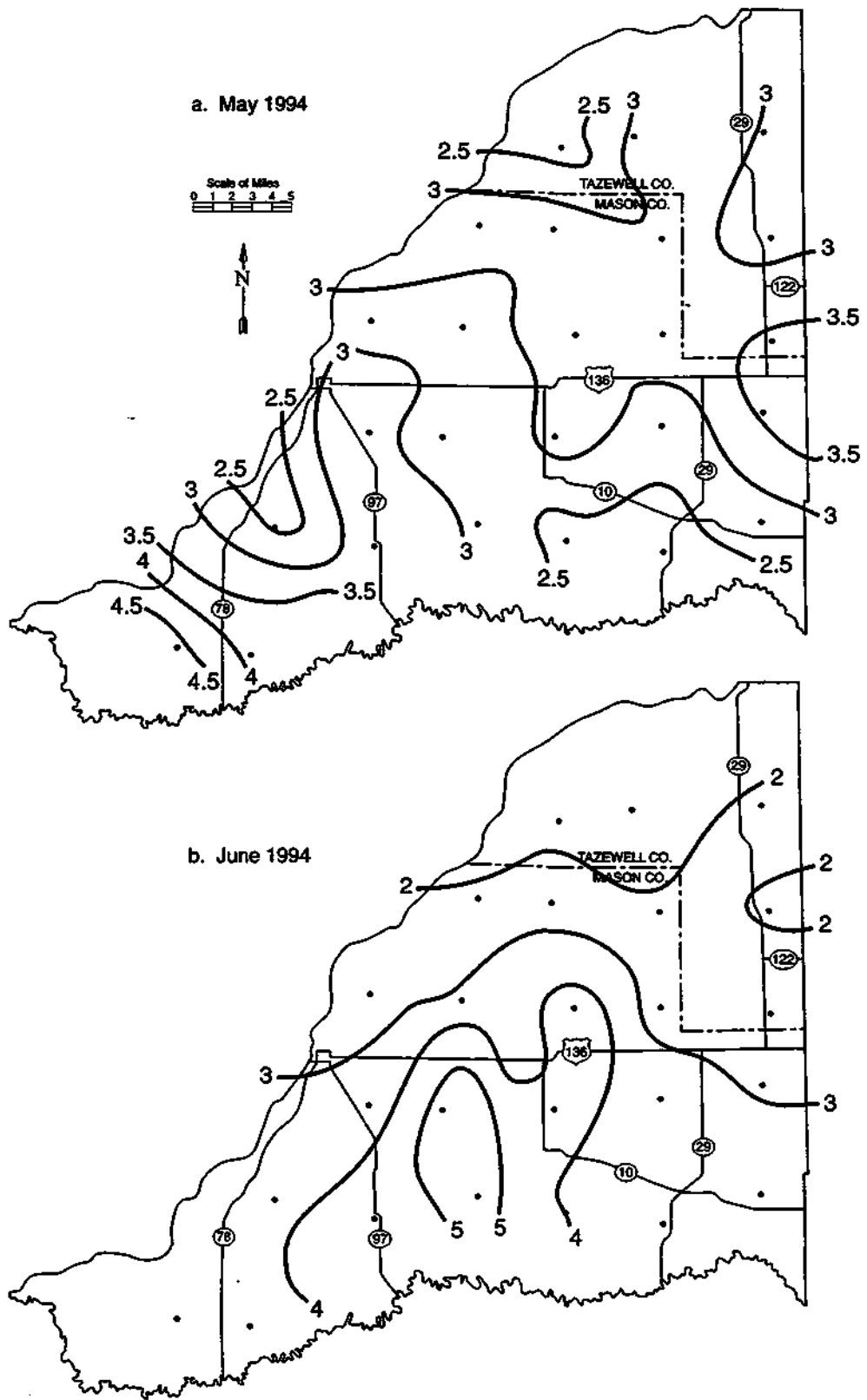


Figure 7. Precipitation pattern (inches) for May 1994 (a), June 1994 (b)

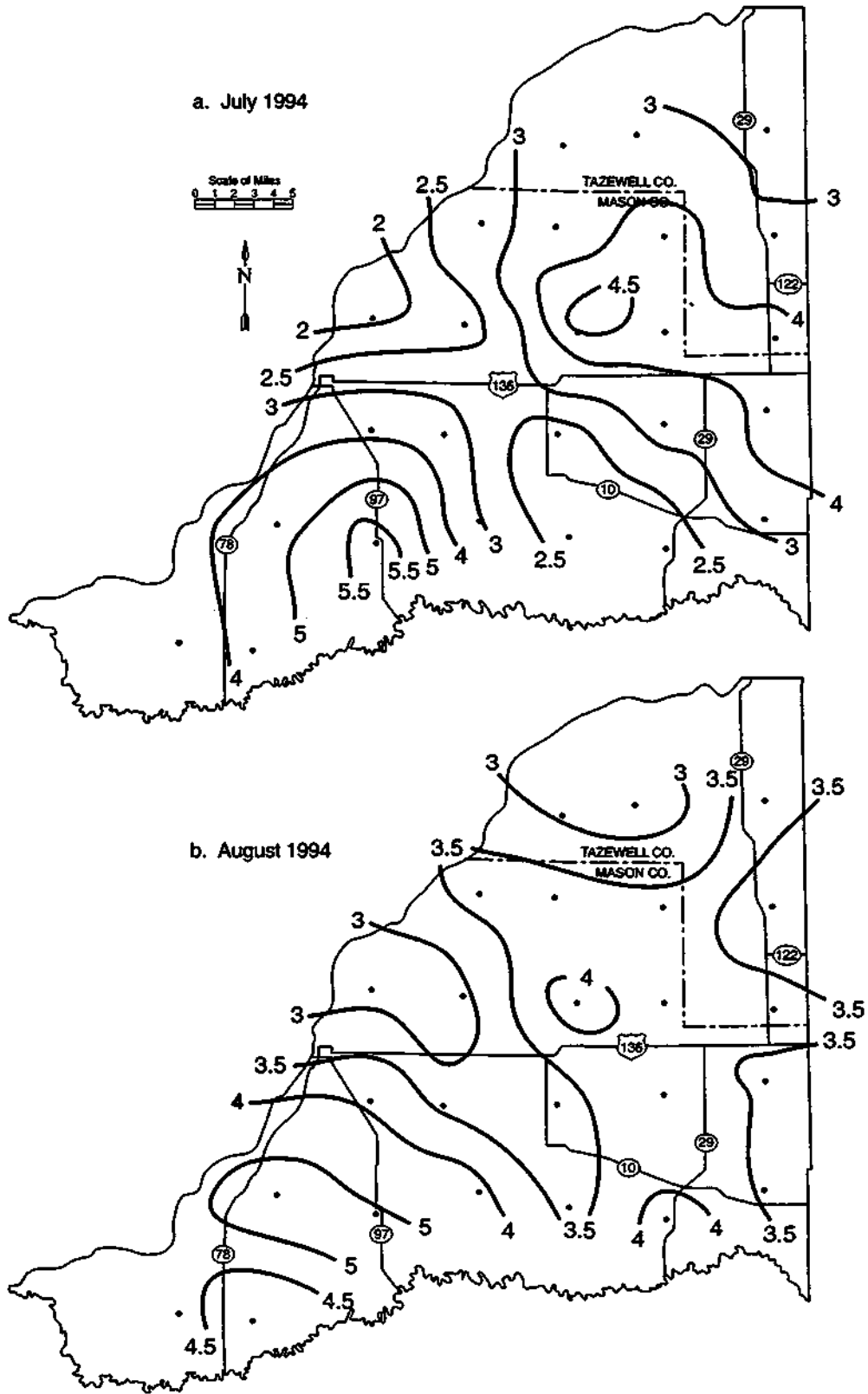


Figure 8. Precipitation pattern (inches) for July 1994 (a), August 1994 (b)

Figures 9 and 10 give graphical views of the network-average monthly variability of precipitation for Year Two alone (Figure 9) and for Years One and Two (Figure 10). Figure 9 reveals that after September 1993, precipitation was average to light during the second year of operation, with April 1994 having somewhat heavier precipitation than other months. Figure 10 plainly shows that the precipitation of June-September 1993 dominated the amounts measured during the first two years of network operation. Again, given the widespread flooding that occurred in the IVWA area because of this heavy rainfall, it was quite fortuitous that the six months following September 1993 were very dry. Appendix IV contains graphs of monthly average precipitation for each of the 25 raingage sites during Year Two.

A total of just 93 storm periods occurred during Year Two (storms 129-221), compared to 128 during Year One. A storm period is defined as a precipitation event separated from preceding and succeeding events across the network by approximately six hours. Appendix V documents four individual significant storms that occurred during Year Two - storms 129, 134, 206, and 207. These storms produced amounts in excess of an annual event (i.e., they produced so much precipitation that they should occur statistically only once per year) at one or more stations.

Storms 129 (September 2-3, 1993) and 134 (September 13-14, 1993), were particularly remarkable precipitation producers, contributing to more than half of the heavy September 1993 amounts across the network. Flooding reached its peak in the IVWA area during this period (see Peppier and Hollinger, 1994, for more about this flooding). Amounts recorded at Sites #15, #24 and #25 during storm 129 exceeded 10-year events (i.e., should occur only once every 10 years), while amounts recorded at a remarkable 18 sites during storm 134, just 10 days later, exceeded a 10-year event. In fact, amounts at nine sites during that storm exceeded a 25-year event, and amounts at six sites exceeded a 50-year event. Those six sites exceeding a 50-year event included Site #13 (5.88 inches in 13 hours), Site #14 (6.14 inches in 24 hours), Site #18 (6.12 inches in 23 hours), Site #19 (6.47 inches in 25 hours), Site #24 (6.62 inches in 24 hours), and Site #25 (6.11 inches in 23 hours). The 6.62 inches at Site #24 and the 5.88 inches at Site #13 came within 0.30 inch and 0.20 inch, respectively, of being 100-year events.

A 10-year event was exceeded during storm 207 at Site #17. Other Year Two storms during which sites nearly exceeded an annual event were storm 178 (April 10-12, 1994; Sites #2 and #25) and storm 203 (July 2, 1994; Site #19).

Finally, precipitation values collected by this network can be compared to ground-water recharge values as computed by Walton (1965) for the Havana Lowlands region. According to Walton, ground-water recharge is generally at a maximum during wet spring months, and in many years there is little or no recharge during July-November. The wet June-September period of 1993 clearly represents a large exception. Recharge rates also vary in space and time, and are particularly a function of the type of soil and subsoil deposits in the region of interest. Because of the geology of the Havana Lowlands region, recharge is usually much greater or more efficient in its western sand/gravel region. Descriptive comments from Walton about the geology and soils of the region and its recharge rates are contained in Peppier and Hollinger (1994).

Excluding September 1993, the relatively lighter precipitation received across the region during the second network year undoubtedly resulted in less recharge to the aquifer than during the first year, allowing most flooded areas to dry. In fact, there were some

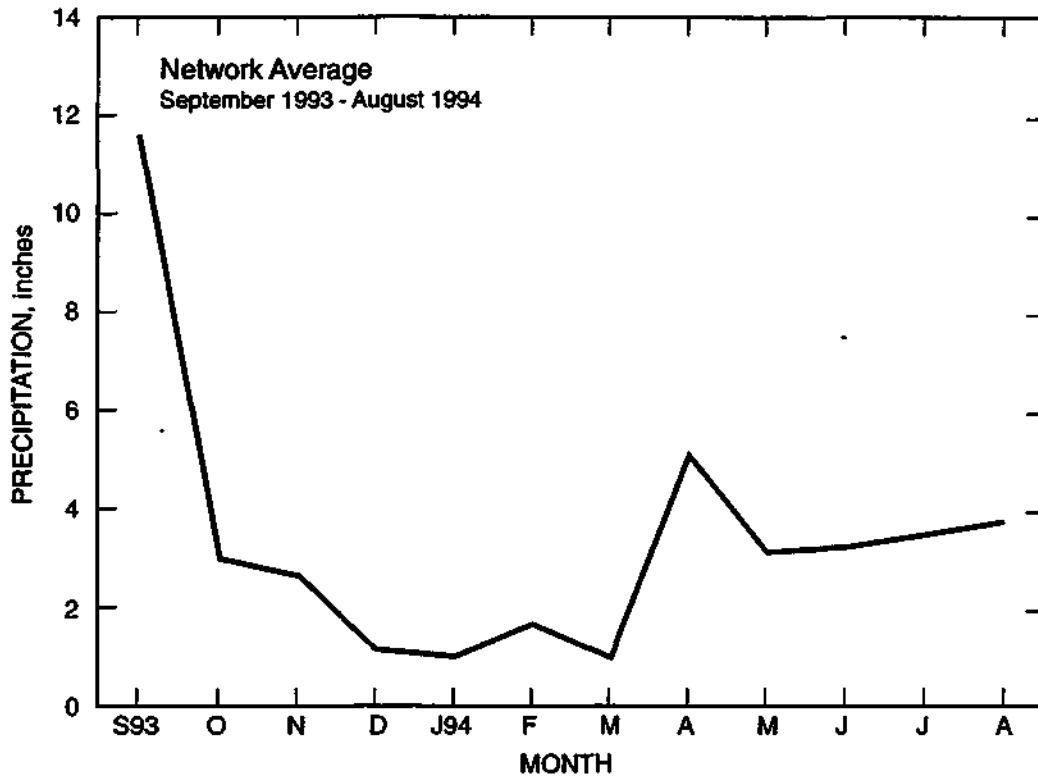


Figure 9. Monthly network average precipitation (inches) for September 1993-August 1994

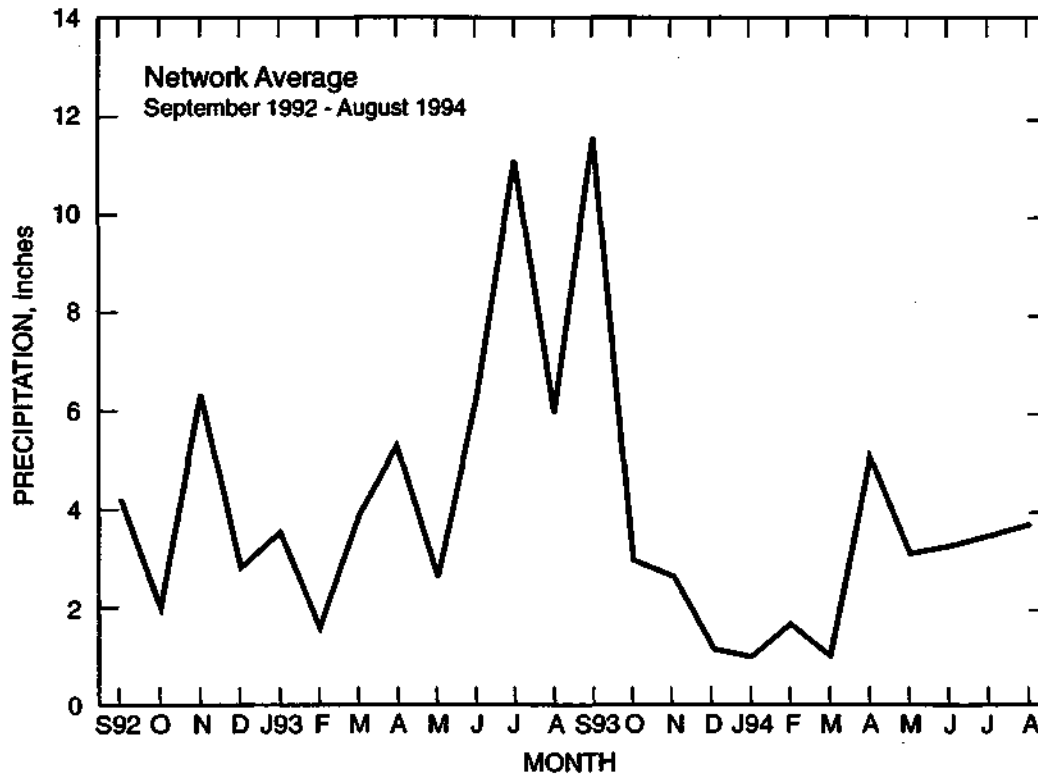


Figure 10. Monthly network average precipitation (inches) for Years One and Two

periods during the 1994 growing season when soils dried to below-normal levels. As in Year One, recharge during Year Two was likely greatest in the sandier western and particularly southwestern portions of the network, mostly because precipitation (largely fueled by September 1993 precipitation) was heaviest in those areas. As described earlier, ground-water flooding in this region reached its peak during September 1993, then gradually diminished.

6. SUMMARY

Data from the second year of operation of the IVWA raingage network have been documented in this report. The data collected during this somewhat drier 12-month period served as a useful contrast to the record-breaking amounts of precipitation measured during the network's first operational year. The exposure and areal coverage of the network still seem to be adequate to capture the precipitation variability of the region.

Because of the relatively dense spacing of the raingages deployed, the network is also providing high quality data for research purposes. Once data are collected from a third year of network operation (September 1994–August 1995), a matrix of correlations of precipitation amounts between raingage sites will be constructed to identify regions of spatial coherency in the precipitation-producing systems traversing the region, allowing further assessment of the spatial variability of the precipitation. Estimates of the probabilities of different storm paths and precipitation patterns in the area should also be possible, since these types of statistics become more stable as the sample size of the database increases.

These data and statistics, in combination with ground-water information now being collected in the area on a routine basis, should enhance the ability of the IVWA to accurately and efficiently manage the region's underground water resources.

7. ACKNOWLEDGMENTS

This work was contracted by the IVWA under grant "Imperial Valley 223." Mr. Morris Bell, chairman of the IVWA, and his board, administer the project. Doug Ward established the digitizing system, including software; Marv Clevenger and Roma Johnson handled all digitizing tasks; Dave Cox drafted the figures for this report, under the supervision of Linda Hascall; and Sarah Hibbeler edited the report. The late Douglas M. A. Jones, ISWS meteorologist emeritus, made the field portion of this project run smoothly, and his efforts are greatly appreciated. The ISWS and IVWA would also like to take this opportunity to thank all of the local Mason/Tazewell County observers, past and present, for their diligence in making this project a success.

8. REFERENCES

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APPENDIX I: RAINGAGE SITE DESCRIPTIONS

This appendix contains site descriptions of each raingage site in the IVWA network as of August 31, 1994. Sites that have been relocated since the network was established in August 1992 are so noted in the "Placement" portion of their site description.

SITE DESCRIPTION		
Site Number: 1		
County: Tazewell	Latitude: 40° 28' 3"	Longitude: 89° 50' 9"
Property Owner: Melvin Fornoff		
Address: 10200 Fornoff Road, Manito, IL 61546		
Telephone: 309-968-6653		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 4695	Gage ID No.: SWS 5068	
Placement: Near apple/pear trees, northeast of a garage. Property on east side of 450 E in Tazewell County, north of 1000 N. Large dog. SWS services. Gage 15 meters northwest of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 2		
County: Tazewell	Latitude: 40° 28' 42"	Longitude: 89° 45' 54"
Property Owner: Ken Becker		
Address: 8479 Townline Road, Manito, IL 61546		
Telephone: 309-545-2207		
Permission Date: 8-15-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 4723	Gage ID No.: SWS 5030	
Placement: In back yard (grass) near garbage burner. Property on south side of 1100 N in Tazewell County west of 900 E. SWS services. Gage 2 meters west of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 3		
County: Tazewell	Latitude: 40° 28' 56"	Longitude: 89° 37' 33"
Property Owner: Lonn Schleder		
Address: RR #3, 11177 S. 14th Street, Pekin, IL 61554		
Telephone: 309-348-2447		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 1463	Gage ID No.: SWS 3693	
<p>Placement: Moved on 5-13-94 to a position about 60 meters north-northeast of original position, which was in a back pasture along a wire fence between a white aluminum shed and a large tree. Present position is between a garage and another shed near a well. Property on northwest corner of the intersection of 1600 E and 1100 N. SWS services. Gage 50 meters north-northwest of lat/lon reading.</p>		
SITE DESCRIPTION		
Site Number: 4		
County: Mason	Latitude: 40° 24' 29"	Longitude: 89° 54' 41"
Property Owner: Ellis Popcorn (Maureen Hanks)		
Address: R.R. #1, Topeka, IL 61567		
Telephone: 309-535-3840		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 7382	Gage ID No.: SWS 6573	
<p>Placement: South of large white office building, between two trees in a grassy area. Property on east side of 2340 E in Mason County, northeast of Goofy Ridge. Mrs. Hanks services. Gage 10 meters south-southwest of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 5		
County: Mason	Latitude: 40° 24' 29"	Longitude: 89° 50' 19"
Property Owner: Joseph Meyer		
Address: R.R. #1, Box 175, Topeka, IL 61567		
Telephone: 309-968-6378		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 5985	Gage ID No.: CDA 000130	
Placement: Next to stone drive in a pasture in front of house. Property on west side of 2750 E in Mason County, south of 2500 N. SWS services. Gage 3 meters east of lat/lon reading.		
SITE DESCRIPTION		
Site Number: 6		
County: Mason	Latitude: 40° 24' 12"	Longitude: 89° 44' 6"
Property Owner: c/o Wes Hilst		
Address: R.R. #3, Box 116, Manito, IL 61546		
Telephone: 309-968-7043		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 5295	Gage ID No.: SWS 5309	
Placement: Next to old farm machinery just north of garden and northeast of green shed. Property located on west side of 3300 E in Mason County just south of 2400 N. SWS services. Gage 18 meters south of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 7		
County: Tazewell	Latitude: 40° 24' 24"	Longitude: 89° 37' 29"
Property Owner: David Van Orman		
Address: 5801 Warner Road, Green Valley, IL 61534		
Telephone: 309-352-5673		
Permission Date: 8-10-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 5935	Gage ID No.: —	
<p>Placement: Moved in May 1993 to a position south of a barn with a green roof, near edge of field. Original position was 30 meters to the northeast, north of the same barn. Both positions are northwest of the house. Property located just east of Green Valley on south side of 600 N in Tazewell County, just west of 1600 E. SWS services. Gage 17 meters west-northwest of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 8		
County: Mason	Latitude: 40° 20' 32"	Longitude: 90° 1' 8"
Property Owner: Gary Blakely		
Address: 18012 E. County Road 1950 N, Havana, IL 62644		
Telephone: 309-543-4949		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 2000	Gage ID No.: US148085	
<p>Placement: East-southeast of house near a small tree. Property located on the north side of 1950 N in Mason County west of 1900 E. Mr. Blakely services. Gage 36 meters east-northeast of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 9		
County: Mason	Latitude: 40° 19' 41"	Longitude: 89° 55' 55"
Property Owner: John Crum		
Address: Box 19, Topeka, IL 61567		
Telephone: 309-535-2080		
Permission Date: 5-14-93		
Installation Date: 5-14-93		
Gage Mfrs. No.: 5986	Gage ID No.: CDA 000132	
<p>Placement: Located in a sparse apple orchard about 70 meters west of house. Original position from 8-24-92 to 5-14-93 was at R.R. #1, Box 6, Topeka, about one mile north-northeast of present position at a farmstead, between a tank and a light pole along a front drive. Present location is on Pear Street in the far southwestern portion of Topeka in Mason County. From 2280 E turn west on 5th Street until you reach Pear Street. Mr. Crum services. Gage 75 meters west-northwest of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 10		
County: Mason	Latitude: 40° 19' 58"	Longitude: 89° 48' 53"
Property Owner: Paul Meeker		
Address: RR #1, Box 31, Forest City, IL 61532		
Telephone: 309-597-2163		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 4679	Gage ID No.: SWS 5100	
<p>Placement: West of hedge row on southwest edge of home property. Property is on north side of 1900 N in Mason County, east of 2800 E, and the gage is about 3 meters north of 1900 E. SWS services. Gage 5 meters northeast of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 11		
County: Mason	Latitude: 40° 20' 2"	Longitude: 89° 44' 4"
Property Owner: Louis Moehring		
Address: 32972 E. County Road 1900 N, Manito, IL 61546		
Telephone: 217-482-3320		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 3362	Gage ID No.: SWS 4450	
Placement: North side (back of) house along a walk. Property is on northwest corner of intersection of 1900 N and 3300 E in Mason County. Mr. Moehring services. Gage 12 meters southwest of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 12		
County: Tazewell	Latitude: 40° 20' 16"	Longitude: 89° 38' 26"
Property Owner: Harold Deiss		
Address: 1327 Route 29, San Jose, IL 62682		
Telephone: 309-247-3535		
Permission Date: 8-10-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 3346	Gage ID No.: SWS 4439	
Placement: East side of Route 29 (1500 E) in Tazewell County in a grassy area southwest of a red shed. Deiss house is 1/4 mile north. Just north of Day Ditch. SWS services. Gage 2 meters south of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 13		
County: Mason	Latitude: 40° 15' 43"	Longitude: 90° 0' 48"
Property Owner: Don Hahn		
Address: R.R. #1, Box 386, Havana, IL 62644		
Telephone: 309-543-4660		
Permission Date: 8-11-92		
Installation Date: 8-25-92		
Gage Mfrs. No.: 5939	Gage ID No.: —	
Placement: Left side of front entrance drive near a short fence. Property on south side of the diagonal 1450 N, east of Route 97. Mr. Hahn services. Gage 3 meters north-northeast of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 14		
County: Mason	Latitude: 40° 15' 52"	Longitude: 89° 56' 33"
Property Owner: Wayne Patterson (650 E. Taintor Rd., Springfield, IL 62702-1755)		
Address: R.R. #1, Box 220, Easton, IL 62633		
Telephone: 309-543-4664		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 4678	Gage ID No.: SWS 5098	
Placement: In a small clearing north of house. Property located on west side of 2200 E in Mason County south of 1500 N. Correspondence address changed to that of Wayne Patterson on 3-26-94. SWS services. Gage 17 meters northwest of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 15		
County: Mason	Latitude: 40° 15' 27"	Longitude: 89° 50' 22"
Property Owner: c/o Joe Umbach		
Address: R.R. #1, Box 156, Easton, IL 62633		
Telephone: 309-562-7611		
Permission Date: 8-12-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 6462	Gage ID No.: CDA 000136	
Placement: Along right side of the house lane which extends north from 1410 N in Mason County between Route 10 and 2800 E. 1410 N runs from southwest to northeast along Central Ditch. SWS services. Gage 2 meters north-northeast of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 16		
County: Mason	Latitude: 40° 16' 5"	Longitude: 89° 44' 9"
Property Owner: Donald Osborn, Sr.		
Address: 32866 E. County Road 1450 N, Mason City, IL 62664		
Telephone: 217-482-5816		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 4659	Gage ID No.: SWS 5059	
Placement: Along right side of drive near pig pen and road (1450 N). Property located on north side of 1450 N just west of 3300 E. Mr. Osborn services. Gage 2 meters east of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 17		
County: Mason	Latitude: 40° 16' 51"	Longitude: 89° 38' 25"
Property Owner: Larry Jennings		
Address: R.R. #1, Box 100, San Jose, IL 62682		
Telephone: 309-247-3781		
Permission Date: 8-11-92		
Installation Date: 8-24-92		
Gage Mfrs. No.: 5280	Gage ID No.: SWS 5317	
Placement: West of garage near back fence and animal petting area. Property located on 3800 E in Mason County just north of 1500 N. SWS services. Gage 34 meters west of lat/lon reading.		
SITE DESCRIPTION		
Site Number: 18		
County: Mason	Latitude: 40° 11' 32"	Longitude: 90° 6' 15"
Property Owner: Vernon Heye		
Address: R.R. #1, Bath, IL 62617		
Telephone: 309-546-2266		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 5278	Gage ID No.: 5308	
Placement: East of white shed near field on east edge of home property. Property located on north side of 900 N in Mason County about 2 miles east of Bath. SWS services. Gage about 37 meters east-northeast of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 19		
County: Mason	Latitude: 40° 11' 1"	Longitude: 90° 0' 19"
Property Owner: Charles W. Lane		
Address: R.R. #1, Box 51, Kilbourne, IL 62655		
Telephone: 309-538-4397		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 4718	Gage ID No.: SWS 5081	
Placement: Along a wire fence separating home property from pig pen, northwest of house. Property located on the west side of Route 97 on southern end of a large curve between 900 N and 800 N. Mr. Lane services. Gage 14 meters northwest of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 20		
County: Mason	Latitude: 40° 11' 46"	Longitude: 89° 54' 56"
Property Owner: Wanda Krause		
Address: R.R. #1, Box 109, Easton, IL 62633		
Telephone: 309-562-7528		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 3771	Gage ID No.: US 148830	
Placement: On east side of 2400 E in Mason County near Jon Krause mailbox. Lane to two homes is on west side of road. Position previous to 12-93 was in a strawberry patch along the same lane about 250 meters to the west. SWS services. Gage 250 meters east of lat/lon reading.		

SITE DESCRIPTION		
Site Number: 21		
County: Mason	Latitude: 40° 11' 10"	Longitude: 89° 49' 39"
Property Owner: John Walters		
Address: 28030 E. County Road 850 N, Mason City, IL 62664		
Telephone: 309-562-7527		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 6294	Gage ID No.: CDA 00013A	
<p>Placement: East of the house and driveway and southeast of a shed. Property located on a hill on the northeast corner of the intersection of 2800 E and 850 N in Mason County. Position previous to 5-20-94 was between a windmill and a bush about 25 meters west of present position. Mrs. Walters services. Gage 25 meters east of lat/lon reading.</p>		
SITE DESCRIPTION		
Site Number: 22		
County: Mason	Latitude: 40° 10' 46"	Longitude: 89° 44' 28"
Property Owner: Joe Swaar		
Address: 32706 E. County Road 800 N, Mason City, IL 62664		
Telephone: 217-482-5571		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 4708	Gage ID No.: SWS 5021	
<p>Placement: On a concrete slab with two 2' x 4's attached to the base of the gage, west of the house and lane on a ridge. Property is located on north side of 800 N in Mason County west of Route 29 and southwest of Mason City. Mr. Swaar services. Gage 25 meters west of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 23		
County: Mason	Latitude: 40° 12' 0"	Longitude: 89° 38' 28"
Property Owner: Dale C. Fancher		
Address: 9482 N. County Road 3800 E, Mason City, IL 62664-7209		
Telephone: 217-482-3506		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 3773	Gage ID No.: US 148832	
<p>Placement: On the west edge of a garden located north of a woodshop and the house. Property located on the west side of 3800 E in Mason County about a half mile north of Route 10, east of Mason City. Mr. Fancher services. Gage 30 meters north-northwest of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 24		
County: Mason	Latitude: 40° 6' 26"	Longitude: 90° 11' 58"
Property Owner: Norman L. Fletcher		
Address: R.R. #1, Box 147, Bath, IL 62617		
Telephone: 309-546-2677		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: —	Gage ID No.: —	
<p>Placement: North of a garage near a grapevine, northeast of the house. Property located on the east side of 800 E in Mason County west of Route 78, just north of 300 N. Mrs. Fletcher services. Gage 32 meters northeast of lat/lon reading.</p>		

SITE DESCRIPTION		
Site Number: 25		
County: Mason	Latitude: 40° 6' 14"	Longitude: 90° 8' 0"
Property Owner: Rocky Adkins		
Address: R.R. #2, Box 16, Chandlerville, IL 62627		
Telephone: 217-458-2587		
Permission Date: 8-11-92		
Installation Date: 8-26-92		
Gage Mfrs. No.: 5947	Gage ID No.: —	
Placement: Next to two tanks and a sign in a small grassy area surrounded by truck access. Property located at Adkins Farms on south side of 300 N (east of Route 78) in Mason County. SWS services. Gage 2 meters south of lat/lon reading.		

APPENDIX II: INSTRUCTIONS FOR RAINGAGE TECHNICIANS

A. Use Central Standard Time:

From October through March, Illinois is in the Central Standard Time zone, so the time your watch shows is the time to use when you write the time and date on the chart. From April through October, subtract one hour from what your watch says, since during the warm season Illinois is in the Central Daylight Time (Eastern Standard Time) zone.

B. Order of Servicing:

1) Old Chart

- a) Unlock and open (slide up) door on the side of the instrument case and then lock door in place to prevent it from falling.
- b) Depress the bucket platform casting to mark the OFF time position on the chart (a vertical trace will be written by the pen).
- c) Note the time on your watch, and move the pen point and arm away from the chart by pushing out on the pen bracket.
- d) Lift up on the drum cylinder that contains the chart in order to disengage it from the chart drive, and remove it out the door.
- e) Remove the chart from the drum and write the OFF date and time on the chart on the red line at the right end of the chart.

2) Bucket

- a) Remove the collector from the top of the gage by rotating it clockwise to disengage the tongue-and-groove assembly, set it down.
- b) Carefully lift the bucket off of the weighing platform if there is water in it and dump the water on the ground.
- c) Reposition the empty bucket on the platform.
- d) Reinstall the collector by setting it on top of the raingage case and turning counterclockwise until the tongue-and-groove assembly meshes.
- e) During wintertime operation, when a quart of antifreeze is in the bucket to prevent freezing, do not dump the bucket contents. We will monitor the increase in liquid in the bucket at the Water Survey (via the chart trace) and come to dispose of the liquid when it approaches the top of the bucket.

3) New Chart

- a) Copy the OFF time from the old chart to the ON time on the new chart (another red line on end of the chart) and write your site number on the chart.

- b) Clip the new chart to the drum cylinder, making sure the crease at the right end of the chart is sharp and the chart is tight on the cylinder.
- c) Wind the chart drive lever until you can't anymore so that the chart drive will be ready to run again for another eight days.
- d) Reinstall the chart cylinder onto the chart drive, making sure the chart cylinder and drive gears mesh. Simply push down on the cylinder and wiggle it a little. You should feel some resistance if done correctly.
- e) Move the pen arm and point over to the chart cylinder with the pen bracket and rotate the cylinder counterclockwise until the pen point coincides with the correct ON time position.
- f) Let the pen point rest right on the chart and depress the platform casting again to make a small vertical line denoting the ON time position.
- g) When you are sure that everything is in order, carefully unlock the door, push the door down, and lock it into place for another week.

4) Problems

- a) If you notice anything unusual about the gage or the chart drive operation, write a note on the upper right corner of the old chart.
- b) If you think the problem requires immediate attention, call Randy Peppier collect at 217-244-1798 (day) or 217-356-6083 (night) to relay the information to him. Situations worthy of immediate attention include confusion over how to perform the operation described above, premature chart-drive stoppage, or unauthorized tampering with the gage. Immediate repairs will be scheduled if necessary.
- c) Once you become experienced with this operation, it will take you less than five minutes to do it. Don't let the above instructions scare you - this operation is actually easier to perform than describe!

5) Disposition of Old Chart

- a) Carefully fold the old chart and place it in one of the postage-paid envelopes provided.
- b) Mail the chart to the State Water Survey.

C. Change in site status:

If at any time you decide that you no longer want the gage on your property or would rather that we service it, please contact Water Survey staff immediately so that they can make new arrangements. It is important to try to keep the sites in the same locations during the course of this project since rainfall generally varies greatly over short distances.

We greatly appreciate your cooperation for this project.

APPENDIX III: DOCUMENTATION OF RAINGAGE MAINTENANCE

This appendix documents major maintenance work carried out at sites in the network from September 1, 1993 through September 16, 1994. All gages were cleaned and lubricated and their calibration checked, during September 8-9, 1993, and again during September 15-16, 1994. Each raingage was releveled and had new pen points and chart drives installed at various times during the year. None of these activities are listed below. Sites not listed needed no major maintenance during the second network year.

SITE #2

9-8-93: Replaced collector.

SITE #3

5-13-94: Moved gage 70 meters northeast of original position, near a well.

SITE #5

9-15-94: Replaced collector and outer case.

SITE #7

9-8-93: Replaced collector.

SITE #12

9-8-93: Reworked gage due to flooding several days earlier.

SITE #15

2-3-94: Adjusted pen arm and checked calibration.

SITE #20

12-93: Moved gage 250 meters east to east side of 2400 E near Jon Krause mailbox.

SITE #21

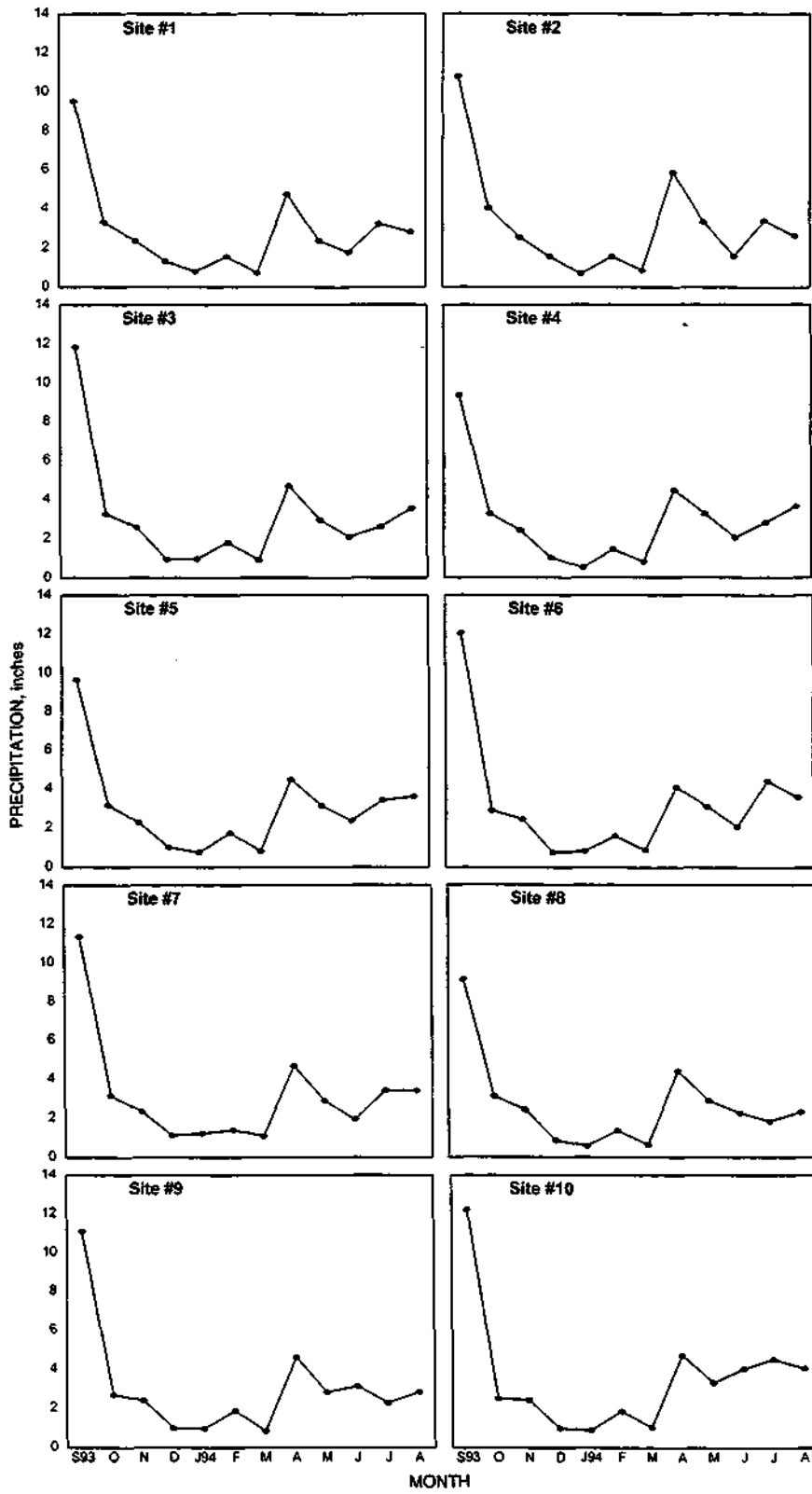
5-20-94: Moved gage 25 meters east, away from new shed.

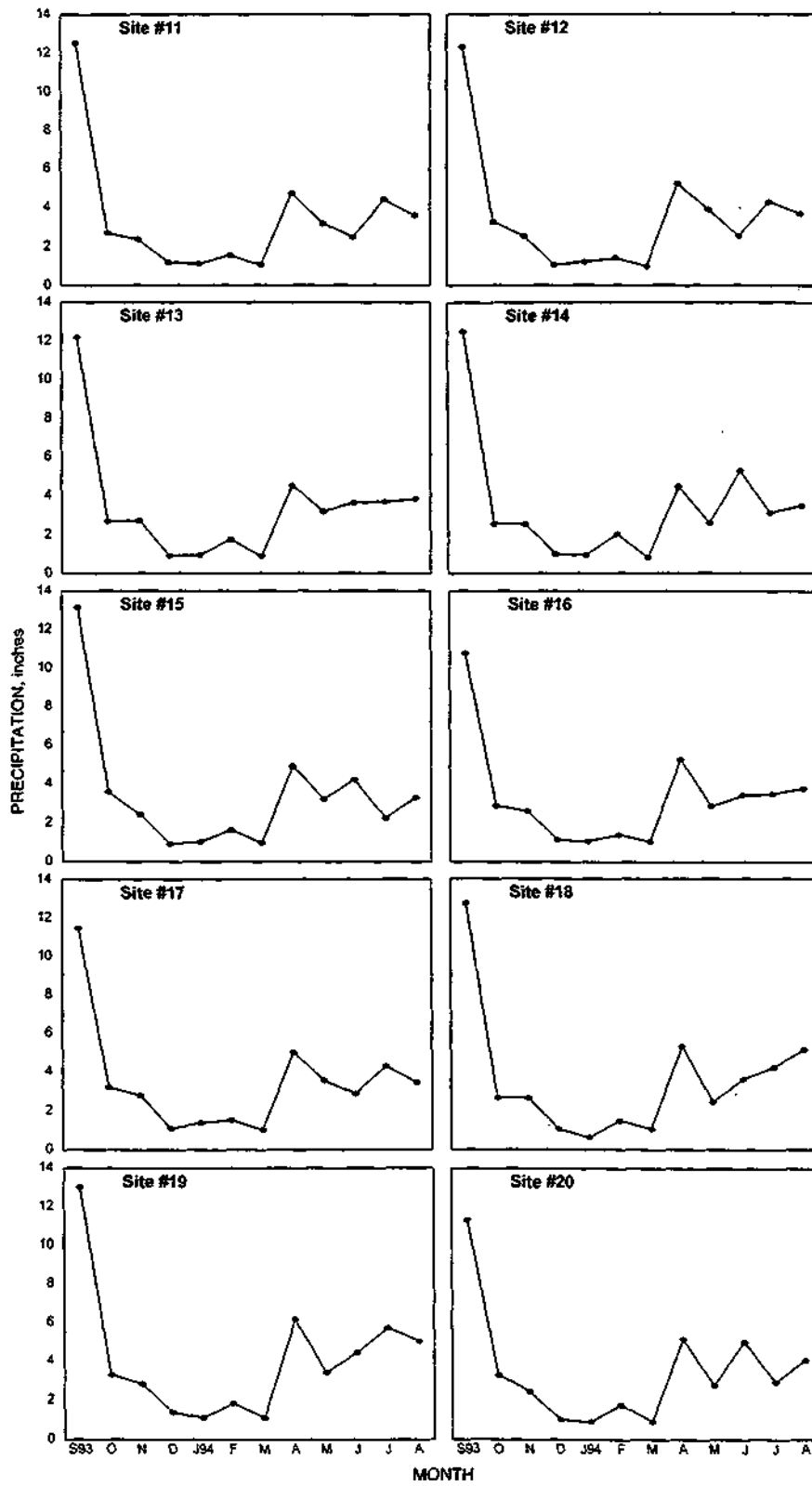
SITE #22

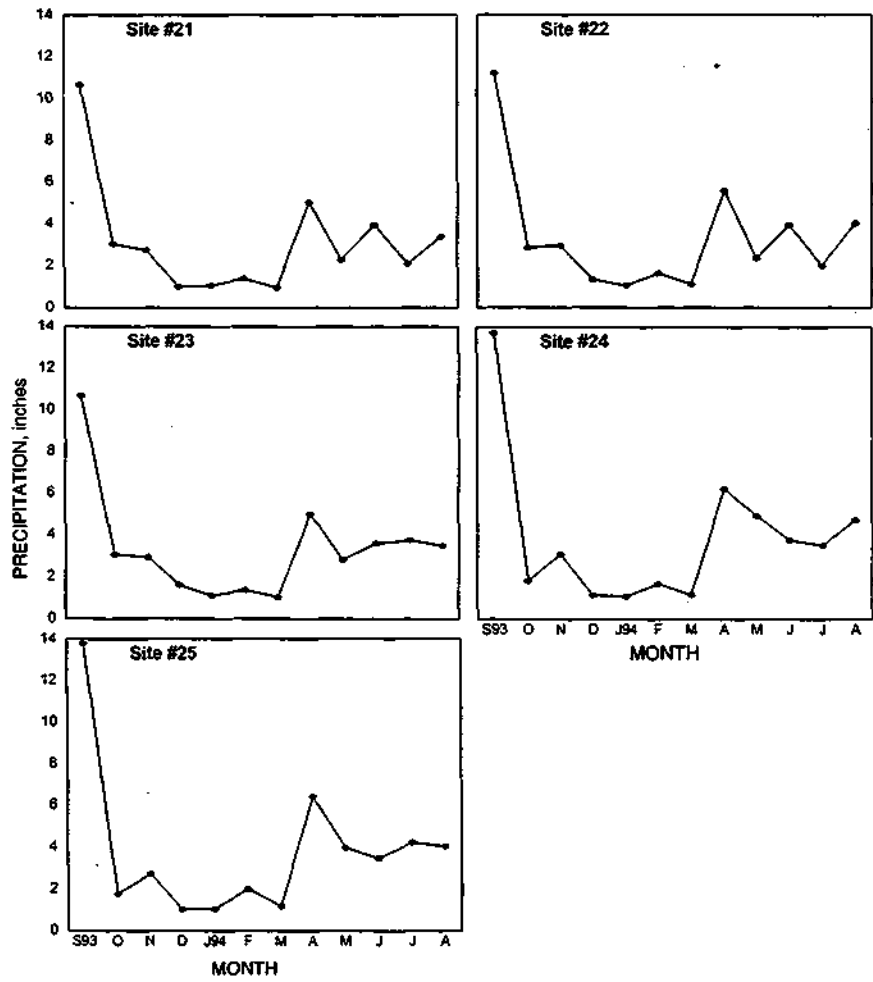
9-9-93: Replaced outer case.

APPENDIX IV: MONTHLY PRECIPITATION VARIABILITY AT EACH SITE

This appendix contains graphs of the monthly variability of precipitation amounts at each site in the IVWA Network. Each graph plots the monthly average precipitation (in inches) for a site for each month from September 1993 through August 1994. Actual monthly amounts are contained in Table 1.







APPENDIX V: DOCUMENTATION OF HEAVY STORM AMOUNTS

This appendix documents all storm amounts that exceeded an annual event (one-year recurrence interval) during the period September 1, 1993, through August 31, 1994. Individual storm durations of one hour to ten days were considered. The rainfall amounts for a one-year recurrence interval and these storm durations for west-central Illinois are given below (Huff and Angel, 1989):

Storm Duration	Rainfall Amount (inches)
1 hour	1.18
2 hours	1.48
3 hours	1.61
6 hours	1.89
12 hours	2.17
18 hours	2.28
24 hours	2.52
48 hours	2.81
72 hours	3.05
5 days	3.48
10 days	4.29

The values listed in the following table match or exceed the numbers above for the given storm duration. An "E" indicates a partial or full estimate for a particular site and storm. The last column indicates whether a particular storm during the second network year exceeded events greater than an annual event (2-year to 100-year recurrence intervals considered).

STORM TOTALS

<u>Storm #</u>	<u>Site #</u>	<u>Date</u>	<u>Duration (hours)</u>	<u>Amount (inches)</u>	<u>Other Events Exceeded</u>
129	1	9/2-3/93	21	3.03	2-year
	2		21	2.90	2-year
	3		27	3.15	2-year
	4		22	2.81-	
	5		21	2.85	
	6		21	3.04	2-year
	7		21	2.74	
	8		22	3.27 E	2-year
	9		22	3.39	2-year
	10		21	3.01	2-year
	11		21	3.86	5-year
	12		22	3.71	5-year
	13		21	3.54	2-year
	14		22	3.80	5-year
	15		21	4.41	10-year
	16		22	3.51	2-year
	17		22	3.25	2-year
	18		22	3.94	5-year
	19		26	3.68	2-year
	20		26	3.42 E	2-year
	21		21	3.11	2-year
	22		24	3.48	2-year
	23		22	3.59 E	2-year
	24		22	4.47	10-year
	25		25	4.79	10-year
134	1	9/13-14/93	22	3.20	2-year
	2		24	4.06	5-year
	3		25	4.58	10-year
	4		22	3.38	2-year
	5		22	3.63	2-year
	6		24	5.49	25-year
	7		24	4.59	10-year
	8		23	3.22	2-year
	9		25	4.42	5-year
	10		22	5.57	25-year
	11		23	5.22	10-year
	12		24	5.10 E	10-year
	13		13	5.88	50-year

STORM TOTALS (Concluded)

<u>Storm #</u>	<u>Site #</u>	<u>Date</u>	<u>Duration (hours)</u>	<u>Amount (inches)</u>	<u>Other Events Exceeded</u>
134	14	9/13-14/93	24	6.14	50-year
	15		22	5.53	25-year
	16		25	4.67	10-year
	17		24	5.16	10-year
	18		23	6.12	50-year
	19		25	6.47	50-year
	20		26	4.83	10-year
	21		26	4.80 E	10-year
	22		26	4.80	10-year
	23		25	3.98	5-year
	24		24	6.62	50-year
	25		23	6.11	50-year
	206		19	7/16/94	5
25		3	2.02		2-year
207	1	7/19/94	3	1.85	
	2		3	1.61	
	5		4	2.02 E	2-year
	6		3	2.21	2-year
	10		4	2.06	2-year
	11		4	2.58	5-year
	12		3	2.19	2-year
	17		2	2.78	10-year
	23		3	1.86	