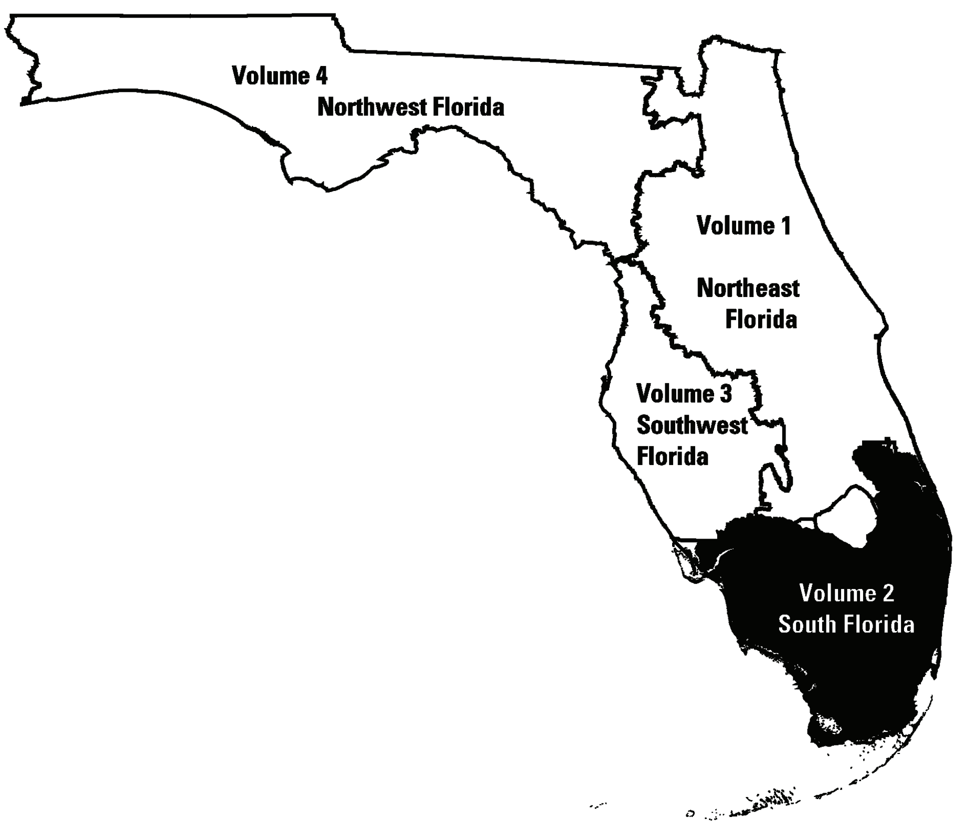
Water Resources Data
Florida
Water Year 2004

Volume 2B. South Florida Ground Water

By S. Prinos, R. Irvin, M. Byrne

Water-Data Report FL-04-2B



Prepared in cooperation with the State of Florida and with other agencies

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VOLUME 2B: SOUTH FLORIDA

PREFACE

This volume of the annual hydrologic data report of Florida is one of a series of annual reports that document hydrologic data gathered from the U.S. Geological Survey's surface- and ground-water data-collection networks in each State, Puerto Rico, and the Trust Territories. These records of streamflow, ground-water levels, and quality of water provide the hydrologic information needed by state, local, and federal agencies, and the private sector for developing and managing our Nation's land and water resources. Hydrologic data for Florida are contained in four volumes. Figure 1 shows the area covered by Volume 2B.

Volume 1.	Northeast Florida
Volume 2.	South Florida
Volume 3.	Southwest Florida
Volume 4.	Northwest Florida

ACKNOWLEDGEMENT

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Hydrologic data for south Florida are contained in two volumes

Volume 2A: Surface Water
Volume 2B: Ground Water

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13. ABSTRACT *(Maximum 200 words)*

Water resources data for 2004 water year in Florida consists of continuous or daily discharge for 405 streams, periodic discharge for 12 streams, continuous or daily stage for 159 streams, periodic stage for 19 stream, peak discharge for 30 streams, and peak stage for 30 streams, continuous or daily elevations for 14 lakes, periodic elevations for 23 lakes, continuous ground-water levels for 408 wells, periodic ground-water levels for 1188 wells, quality of water data for 140 surface-water sites, and 240 wells.

The data for South Florida included continuous or daily discharge for 86 streams, continuous or daily stage for 54 streams, no peak stage discharge for streams, 1 continuous elevation for lake, continuous ground-water levels for 257 wells, periodic ground-water levels for 226 wells, water quality for 39 surface-water sites, and 149 wells.

These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State, and Federal agencies in Florida.

14. SUBJECT TERMS

***Florida, *Hydrologic data, *Surface Water, *Ground Water, *Water Quality, Flow rate, Gaging stations, Lakes, Reservoirs, Chemical analyses, Sediments, Water temperatures, Sampling sites, Water levels, Water analyses, Elevations, Water wells.**

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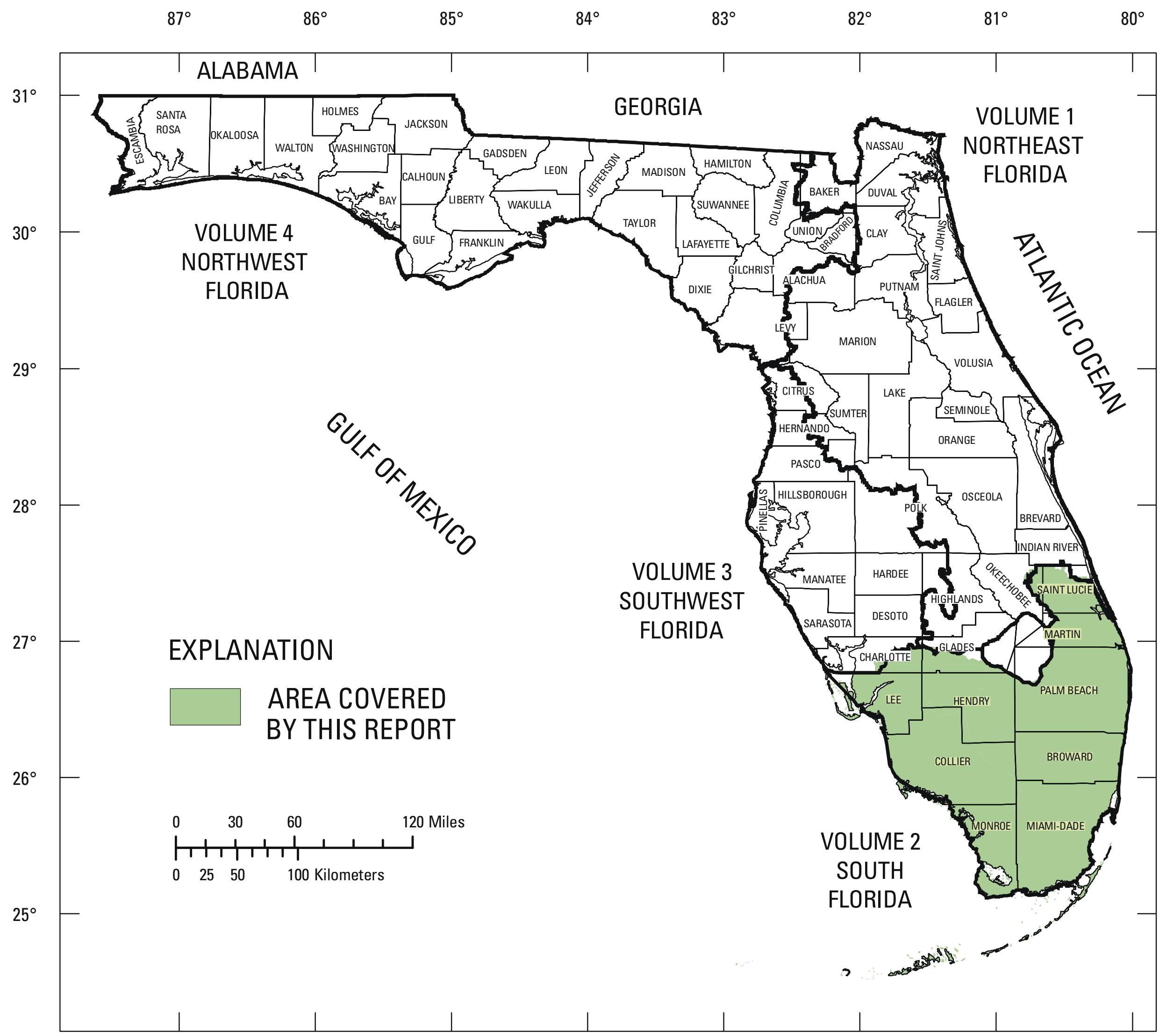

Figure 1. Geographic area covered by this report.

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VOLUME 2B: SOUTH FLORIDA

CONTENTS

CONTENTS (continued)

ILLUSTRATIONS

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INTRODUCTION

The U.S. Geological Survey (USGS), in cooperation with State, County, and other Federal agencies, obtains a large amount of data pertaining to the water resources of Florida each water year. These data, accumulated during many water years, constitute a valuable data base for developing an improved understanding of the water resources of the state. To make these data readily available to interested parties outside the USGS, the data are published annually in this report series entitled "Water Resources Data - Florida, Volume 2A: South Florida Surface Water and Volume 2B: South Florida Ground Water".

This report series includes records of stage, discharge, and water quality for streams; stage, contents, and water quality for lakes; and ground-water levels, contents, and water quality of ground-water wells. The data for South Florida include continuous or daily discharge for 86 streams, continuous or daily stage for 54 streams (including stage published at discharge and stage only sites), continuous elevations for 1 lake, continuous ground-water levels for 257 wells, periodic ground-water levels for 226 wells, and quality-of-water data for 39 surface-water sites and 149 wells.

Publication of this series of annual reports for Florida began with the 1961 water year, with a report that contained only data relating to the quantities of surface water. For the 1964 water year, a similar report was introduced that contained only data relating to water quality. For the 1975 water year, the report format was modified to one volume presenting data on quantities of surface water, quality of surface and ground water, and ground-water levels. For the 1977 water year, the report format was modified to a two volume set: one volume presenting data on quantity as well as quality of surface water and one volume presenting data on water levels along with quality of ground water.

Prior to introduction of this series and for several concurrent water years, water-resources data for Florida were published in USGS Water-Supply Papers. Data on stream discharge and stage and on lake or reservoir contents and stage through September 1960 were published annually under the title "Surface-Water Supply of the United States". For the 1961 through 1970 water years, the data were published in two 5-year reports. Data on chemical quality, temperature, and suspended sediment for the 1941 through 1970 water years were published annually under the title "Quality of Surface Waters of the United States", and water levels for the 1935 through 1974 water years were published under the title "Ground-Water Levels in the United States". The aforementioned Water-Supply Papers may be consulted in the federal repository libraries of the principal cities of the United States and may be purchased from the U.S. Geological Survey, Branch of Information Services, Box 25286, Federal Center, Denver, CO 80115 (telephone: 888-ASK-USGS).

Similar reports are published annually by the USGS for all of the United States. These official USGS reports have an identification number consisting of the two-letter State abbreviation, the last two digits of the water year, and the volume number. For example, this volume is identified as "U.S. Geological Survey Water-Data Report FL-xx-2B," where xx represents the current water year. For archiving and general distribution, reports for the 1971-74 water years also are identified as water-data reports. These water-data reports are for sale in paper copy or microfiche by the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Additional information, including current prices, for ordering specific reports may be obtained from the Office Chief at the address given on the back of the title page or by telephone (305) 717-5800.

VOLUME 2B: SOUTH FLORIDA

COOPERATION

The USGS and various Federal, State, and local organizations have had cooperative agreements for the collection of water-resource records since 1930. Organizations that assisted in collecting the data presented in this report through cooperative agreement with the USGS are:

Broward County
City of Boca Raton
City of Cape Coral
City of Ft. Lauderdale
City of Hallandale Beach
City of Hollywood
Everglades National Park
Florida Keys Aqueduct Authority
Lee County
Miami-Dade County Department of Environmental Resource Management
Seminole Tribe of Florida
South Florida Water Management District
St. Lucie County
U.S. Army Corps of Engineers
U.S. Fish and Wildlife Service

Organizations that provided data are acknowledged in station manuscripts.

SUMMARY OF HYDROLOGIC CONDITIONS

This section summarizes important hydrologic events that occurred during the 2004 water year (October 1, 2003 to September 30, 2004) as well as significant natural and water-management responses to these events. Figure 2 provides a frame of reference for some of the major land areas of hydrologic significance mentioned in the summary.

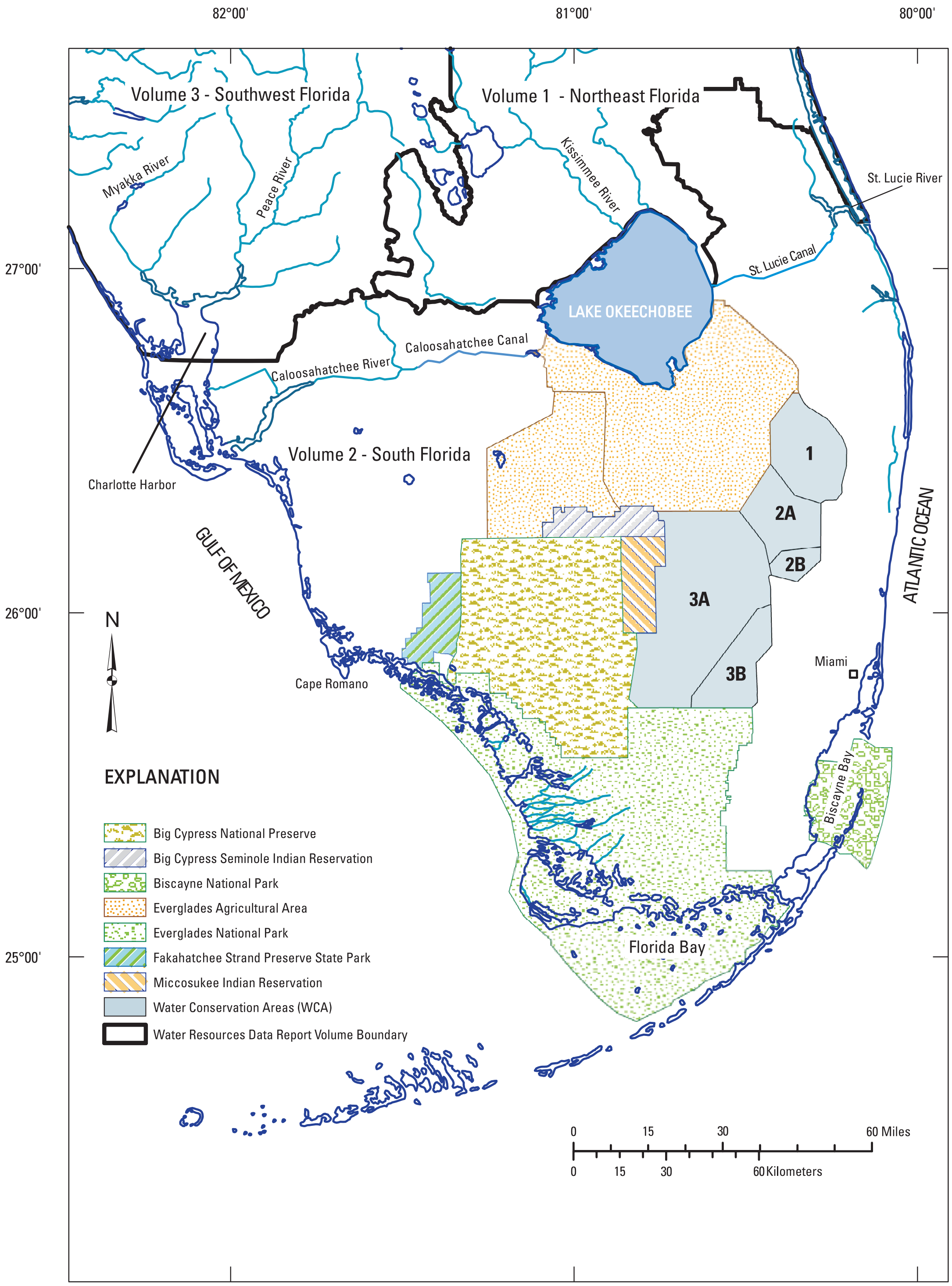


Figure 2. South Florida areas of hydrologic significance.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

GROUND-WATER MONITORING NETWORK

During the 2004 water year (October 1, 2003 to September 30, 2004), the Florida Integrated Science Center - Water and Restoration Studies (FISC-WRS) monitored 511 wells in southern Florida to assess regional ground-water conditions. In southeastern Florida, the principal aquifers monitored are the Biscayne aquifer in Miami-Dade and Broward Counties (209 wells) and the surficial aquifer system in Palm Beach, St. Lucie, and Martin Counties (52 wells). In southwestern Florida, the principal aquifers are the water-table aquifer (86 wells), lower Tamiami aquifer (49 wells), sandstone aquifer (44 wells), mid-Hawthorn aquifer (39 wells), lower Hawthorn aquifer (or lower Hawthorn producing zone) (25 wells), and the Floridan aquifer system (7 wells). The generalized geology and hydrogeology of southern Florida is shown in figure 3.

DATA FROM SELECTED WELLS

The most extensive data are provided by 262 monitoring wells equipped with data recorders that measure hourly water levels. The daily maximum water-level elevations presented in this report are derived from these hourly measurements. Seven recorder-equipped wells have been selected as index stations to depict ground-water conditions for the 2004 water year. These wells were selected to show changes in ground-water levels that occurred in seven municipal water-supply aquifers used in southern Florida. Relations shown for these index wells can only indicate changes occurring in the aquifers in the vicinity of each well.

A detailed assessment of hydrologic conditions throughout each aquifer would require similar statistical evaluations of data from many additional wells. For detailed assessment of aquifer conditions, the USGS has performed statistical analyses of data from additional network wells, and results are available at the U.S. Geological Survey (USGS) Current Water-level Conditions website *http://www.sflorida.er.usgs.gov/ddn_data/index.html*.

Two hydrographs are shown for each of the seven selected stations (figs. 4-10). The first hydrograph compares the water levels for the 2004 water year to historical water-level data. Daily maximum water levels from the 2004 water year are compared to: (1) normal monthly means of the daily maximum water levels, computed using all data available for each month of the period October 1979 to September 2004; (2) highest and lowest daily maximum water levels for the period of record; and (3) the monthly standard deviation of water levels above and below the normal monthly mean. Relations depicted in this first graph could be skewed by long-term water-level trends.

The second hydrograph shows the annual mean of daily maximum water levels and statistical data obtained from the Seasonal Kendall Trend Test (SKTT), depicting long-term trends. The SKTT is a nonparametric test for a monotonic trend in daily values. Two results of this test are the p-value and the Seasonal Kendall Slope Estimator (SKSE). The p-value indicates whether the trend determined by the SKTT is statistically significant. The null hypothesis for this test assumes that the random variable (water level) has not changed over time. The test makes pairwise comparisons of data values from the same seasons to eliminate seasonal variability. If the null hypothesis is disproven (p-values less than 0.05), there is a statistically significant trend in the data. The SKSE is a positive or negative slope representing a trend in water levels that is either increasing or decreasing. The SKSE is expressed as the change in water level in feet per year. The SKTT is determined using monthly mean values.

The statistical analyses used to evaluate the water-level data can be affected by missing data. Almost all index stations selected have periods of missing data. Cooperative support for ground-water monitoring at some locations has fluctuated. As a result, monitoring at some wells was terminated, but later resumed. Additionally, some stations experienced mechanical problems with the float system or water-level recorder. One example is L-2434 (fig. 10), which is one of the only recorder-equipped monitoring stations in the lower Hawthorn producing zone in southwestern Florida. Water levels at this station fluctuate rapidly and extensively, The mechanical systems used to monitor the well used to slip or become entangled. This necessitated the deletion of some segments of erroneous data until a submersible pressure transducer was installed during the 1997 water year. Pressure transducers at stations with rapidly fluctuating water levels have provided a more complete record than previously possible using mechanical devices.

Southeastern Geological Society in Florida Bureau of Geology Special Publication 28	This report				
	Southwestern Florida (Lee, Collier, and Hendry Counties)		Southeastern Florida (Miami-Dade and Broward Counties)		Southeastern Florida (Martin, Palm Beach, and St. Lucie Counties)
Surficial aquifer system	Surficial aquifer system	Water-table aquifer	Surficial aquifer system	Biscayne aquifer	Surficial aquifer system
		Confining beds		Semiconfining unit	
				Gray limestone aquifer	
		Lower Tamiami aquifer		Semiconfining unit	
Intermediate aquifer system	Intermediate aquifer system	Confining unit	Intermediate confining unit		Intermediate confining unit
		Sandstone aquifer			
		Confining unit			
		Mid-Hawthorn aquifer			
		Confining unit			
Floridan aquifer system	Floridan aquifer system	Lower Hawthorn producing zone	Floridan aquifer system		Floridan aquifer system
		Remaining portion of the Floridan aquifer system			

Figure 3. Generalized geology and hydrogeology of southern Florida (Prinos and others, 2002)

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

The data analyzed were not censored for missing record because certain stations, such as L-2434, would have insufficient data for analysis if all partial monthly or annual records were removed. Despite the missing data from well L-2434, there is clearly a significant trend toward decreased water levels that is apparent in the record available. This trend must be considered in order to understand why the current water-level data remain below the normal monthly mean water levels from this well.

In the second hydrograph presented for each index station, dashed lines indicate periods for which the computed annual means included one or more months that were missing more than 15 days. The SKSE provided for these trends should also be considered approximate. Within the applicable graphs, the word "approximately" is used to indicate uncertainty for those stations that have excessive periods of missing record.

LONG-TERM TRENDS

The potential effect of long-term trends must be considered before current ground-water conditions can be reasonably evaluated. Hydrographs showing daily ground-water levels, means, and SKTT statistics (figs. 4-10) show statistically significant (p-value less than 0.05) long-term trends in water-levels at all index wells, except for well PB-561 (fig. 5, surficial aquifer system). Trends were evaluated for the 1980-2004 water-year period for all index stations, except L-2434; which only had record available since 1981.

Well S-196A (fig. 4), completed in the Biscayne aquifer in Miami-Dade County indicates a water-level increase of about 0.01 ft/yr (foot per year). Well C-496 (fig. 6), completed in the water-table aquifer in Collier County indicates a water-level increase of 0.02 ft/yr.

Wells completed in the lower Tamiami aquifer (fig. 7, L-2194), sandstone aquifer (fig. 8, L-729), mid-Hawthorn aquifer (fig. 9, L-1993), and lower Hawthorn producing zone (fig. 10, L-2434) in Lee County, all indicate long-term water-level declines. A 0.10 ft/yr downward trend in water-level data from well L-2194 was determined. This represents an approximate 2-ft decrease in average water levels for the 1980 to 2004 period (fig. 7). Water-level data from well L-729 indicated a 0.22 ft/yr downward trend that represents an approximate 6-ft decline in average water levels for the same period (fig. 8). Water level data from well L-1993 indicated a 0.71 ft/yr downward trend that represents an approximate 18-ft decline in average water levels for the 1980 to 2004 period (fig. 9). Water-level data from well L-2434 indicated an overall downward trend of 1.49 ft/yr, representing an approximate 36-ft decline in water levels for the 1981 to 2004 period (fig. 10). The trend in water levels in well L-2434 has resulted in period-of-record extreme minimum water levels that are progressively lower each year during the 1999 to 2004 period. Wells L-729, L-1993, and L-2194 are all completed in confined aquifers and located in areas affected by municipal water-supply withdrawals.

Because of the effect of substantial long-term declines in water level at wells L-729 (fig. 8, sandstone aquifer), L-1993 (fig. 9, mid-Hawthorn aquifer), and L-2434 (fig. 10, lower Hawthorn producing zone), recent water levels are, on average, below the monthly means of historic water levels (figs. 7-10). These monthly means are influenced by water-levels that had been much higher in the past. The effect of the declining water levels on monthly means of historic water levels is most obvious in the 2004 water year hydrograph from well L-1993 (fig. 9). Therefore, comparative analysis of recent and historical water levels is required to develop a comprehensive understanding of long-term water-level trends.

RAINFALL

The water-table aquifer in southwestern Florida and the Biscayne aquifer in Broward and Miami-Dade counties are locally named aquifers within the surficial aquifer system (fig. 3). Water levels in the surficial aquifer system respond readily to precipitation. The wells completed in these aquifers usually indicate water-level increases in response to rainfall events. The same is true for most wells completed in the lower Tamiami aquifer because a portion of this aquifer in southern Florida is unconfined. The response of water levels to precipitation in the deep confined aquifers is less pronounced. This is because the recharge areas of the deep confined aquifers are in the central Florida. In the deeper confined aquifers, the effects of municipal water-supply withdrawals on aquifer water levels are often more evident than the water-level variations caused by rainfall events. But all wells in all aquifers monitored indicate a seasonal variation in water levels that corresponds to the seasonal variation in rainfall.

Rainfall data collected and evaluated by the South Florida Water Management District (SFWMD) during the 2004 water year, provide a framework for understanding monthly water level variations (South Florida Water Management District, 2005). The rainfall data provided by the SFWMD for southern Florida are subdivided into 16 geographic areas. Monthly rainfall totals from individual stations within each area were averaged and compared to the historical total monthly rainfall averages. The percentage of average monthly rainfall is computed for each of the 16 geographic areas. This percentage is used throughout the discussion of ground-water conditions for the 2004 water year.

Weekly precipitation anomalies (percentage of 1971 to 2000 normal), are provided by the National Climatic Data Center, National Oceanic and Atmospheric Administration (NCDC-NOAA) (2005), for the years 2003 and 2004. The weekly precipitation anomalies were computed for the entire United States and include two geographic areas in southern Florida. The first geographic area is southeastern Florida from Key Largo to St. Lucie County. The second geographic area includes the rest of southern Florida, south of the northern extent of Lake Okeechobee. Unlike the percentages of average monthly rainfall provided by SFWMD, which are exact values, the weekly precipitation anomalies provided by NCDC-NOAA are divided into seven categories or ranges: very dry (less than 30 percent of average), severely dry (30 to 50 percent of average), moderately dry (50 to 70 percent of average), mid range (70 to 140 percent of average), moderately moist (140 to 200 percent of average), very moist (200 to 330 percent of average), and extremely moist (greater than 330 percent of average). Weekly and monthly precipitation anomalies were used in conjunction with water-level data to describe hydrologic conditions in aquifers during the 2004 water year.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

GROUND-WATER CONDITIONS DURING THE 2004 WATER YEAR

Water levels in well C-496 (fig. 6, water-table aquifer) were above normal monthly mean water levels for about 9 months during the 2004 water year. This may be explained, in part, by the 0.02 ft/yr long-term water-level increase observed in this well. Conversely water levels in wells PB-561 (fig. 5, surficial aquifer system), L-729 (fig. 8, sandstone aquifer), L-1993 (fig. 9, mid-Hawthorn aquifer), and L-2434 (fig. 10, lower Hawthorn producing zone) were below normal monthly mean water levels for most of the year. This is consistent with the -0.22, -0.71, and -1.49 ft/yr water-level trends observed, respectively, in wells L-729 (fig. 8, sandstone aquifer), L-1993 (fig. 9, mid-Hawthorn aquifer), and L-2434 (fig. 10, lower Hawthorn producing zone). However, there was no statistically significant long-term water-level trend at well PB-561 (fig. 5, surficial aquifer system). Annual means of water-level data from this well suggest a general decline since about 1999.

During October, rainfall was substantially lower than normal (8 to 39 percent of average) throughout southern Florida. Water levels in all wells declined during this month. Water levels in wells S-196A (fig. 4, Biscayne aquifer), C-496 (fig. 6, water-table aquifer), L-2194 (fig. 7, lower Tamiami aquifer), and L-729 (fig. 8, sandstone aquifer) all declined by about one to two standard deviations. Water levels in well S-196A (fig. 4, Biscayne aquifer) and L-729 (fig. 8, sandstone aquifer) declined from about one standard deviation above the mean to about half of one standard deviation below the mean. Water levels in well L-2194 (fig. 7, lower Tamiami aquifer) decreased from about one standard deviation above the mean in the beginning of the month to near normal monthly mean water level by the end of the month. Water-level declines were slight in wells L-1993 and PB-561.

Rainfall during the first week of November was 200 to 330 percent of average. As a result, most of the index wells indicated increases of one to two standard deviations in water levels during the first week of the month. Water levels in wells S-196A (fig. 4, Biscayne aquifer) and C-496 (fig. 6, water-table aquifer) increased to about two standard deviations above the normal monthly mean. Water levels in well L-2194 (fig. 7, lower Tamiami aquifer) increased to about one standard deviation above the normal monthly mean. Water levels at wells PB-561 (fig. 5, surficial aquifer system) and L-729 (fig. 8, sandstone aquifer) increased from about one standard deviation below the normal monthly mean to levels slightly above the normal monthly mean. Rainfall during the remaining 3 weeks of November was substantially lower than normal (less then 30 percent of average). Water levels in all of the index wells declined during this period. Rainfall for the month was 86 to 114 percent of average in southwestern Florida, 98 to 152 percent of average in southeastern Florida, and 59 to 87 percent of average in south-central Florida.

During the first, second, and fourth weeks of December 2003, rainfall was generally substantially lower than normal (30 to 50 percent of average or less). Rainfall in the third week of the month was substantially greater than normal (greater than 330 percent of normal in southwestern and south-central Florida and 200 to 330 percent of normal in southeastern Florida). As a result, water levels generally declined throughout the month but increased during the third week of the month. During the third week of the month, water levels in wells S-196A (fig. 4, Biscayne aquifer) and C-496 (fig. 6, water-table aquifer) increased to levels slightly greater than one standard deviation above the normal monthly mean, and water levels in wells PB-561 (fig. 5, surficial aquifer system) and L-729 (fig. 8, sandstone aquifer) increased to levels slightly below the normal monthly mean by the middle of the month. Water levels at well L-2194 (fig. 7, lower Tamiami aquifer) increased to levels slightly above the normal monthly mean. Rainfall during the month varied spatially from 47 (eastern Miami-Dade geographic area) to 184 (east Caloosahatchee geographic area) percent of average.

During January 2004, rainfall generally was substantially lower than normal (less than 30 percent of average), except during the last week of the month. Rainfall during this week exceeded 330 percent of average. During most of the month, water levels for most of the index wells declined, except for monitoring well L-729 (fig. 8, sandstone aquifer) in Lee County where water levels increased from values lower than one standard deviation below the normal monthly mean in the mid-January to about normal monthly mean values at the end of the month. Water levels in most of the index wells increased at the end of the month in response to heavy rainfall in late January. This heavy rainfall late in the month throughout most of southern Florida also resulted in monthly rainfall totals that were slightly above normal despite the prevailing dry conditions that existed during the first 3 weeks of the month. Monthly rainfall totals varied spatially from 71 (eastern Palm Beach geographic area) to an estimated 190 (Everglades National Park geographic area) percent of average.

During the first 3 weeks of February, rainfall in southern Florida varied temporally from normal (70 to 140 percent of average) to well below normal (less than 30 percent of average). Rainfall during the last week of February was much higher than normal (between 200 and 330 percent of average in southeastern Florida and more than 330 percent of average in southwestern and south-central Florida). Monthly rainfall totals were about normal for southern Florida. Monthly rainfall varied spatially from 65 (eastern Broward geographic area) to 170 (Everglades National Park geographic area) percent of average. Water levels at most index stations increased twice: once at the beginning of the month as a result of heavy rainfall late in January and early in February, and again at the end of the month as a result of heavy rainfall in the last week of February. During the first week of the month, water levels in well S-196A (fig. 4, Biscayne aquifer) increased from about the normal monthly mean to slightly above one standard deviation above the normal monthly mean. At the end of the month water levels in S-196A again rose to about one standard deviation above the normal monthly mean. Water levels at well PB-561 (fig. 5, surficial aquifer system), increased from one standard deviation below the normal monthly mean at the beginning of the month to about one half of one standard deviation below the normal monthly mean.

During March, rainfall was substantially lower than average. Monthly rainfall ranged spatially from 3 to 37 percent of average throughout southern Florida. During this month, water levels for all the index wells declined. Water levels at well S-196A (fig. 4, Biscayne aquifer) declined from one standard deviation above normal monthly mean at the beginning of the month to about one standard deviation below normal monthly mean by the end of the month Water levels at well C-496 (fig. 6, water-table aquifer) were about one standard deviation above the normal monthly mean at the beginning of March and declined at about the normal rate during the month. Water levels at well L-2194 (fig. 7, lower Tamiami aquifer) and L-729 (fig. 8, sandstone aquifer) declined from about the normal monthly mean at the beginning of the month to about one standard deviation below the normal monthly mean by the end of the month. Water levels at well L-2434 (fig. 10, lower Hawthorn producing zone) declined to about two standard deviations below the normal monthly mean.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

Rainfall during the month of April ranged spatially from about normal to a little below normal (71 to 124 percent of average). Rainfall was generally lowest in south-central Florida and highest in southwestern Florida. Abundant rainfall (200 to 330 percent of average) occurred in the third week of the month; however, rainfall during the rest of the month was less than 30 percent of average rainfall. As a result of rainfall in the third week, water levels observed at index wells rebounded. Water levels in index wells S-196A (fig. 4, Biscayne aquifer), PB-561 (fig. 5, surficial aquifer system), and L-2194 (fig. 7, lower Tamiami aquifer) were generally a little higher near the end of the month than at the beginning of the month. Water levels at these wells were generally between the normal monthly mean and one standard deviation below the normal monthly mean during April. Water levels in well C-496 (fig. 6, water-table aquifer) declined sharply during the month - from slightly below one standard deviation above the normal monthly mean to a little above the normal monthly mean.

May rainfall varied spatially and temporally. During the first week of May, rainfall was 50 to 70 percent of average in southeastern Florida and 70 to 140 percent of average in south-central and southwestern Florida. During the remaining weeks, very dry conditions prevailed (generally less than 30 percent of average.) Resulting monthly rainfall was substantially lower than normal. Rainfall for the month varied spatially from 16 to 50 percent of average. Water levels in all of the index wells declined during the month. Water levels in wells S-196A (fig. 4, Biscayne aquifer) and C-496 (fig. 6, water table aquifer) declined from a little above the normal monthly mean to about one standard deviation below the normal monthly mean. Water levels in well L-2194 (fig. 7, lower Tamiami aquifer) and L-729 (fig. 8, sandstone aquifer) declined to two standard deviations below the normal monthly mean.

On June 2, water levels in well L-2434 (fig. 7, lower Tamiami aquifer) declined to a new period of record lowest daily maximum water level (43.44 ft below the National Geodetic Vertical Datum of 1929). By the middle of the first week of June, water levels in well S-196A (fig. 4, Biscayne aquifer) had declined to about 1.5 standard deviations below the normal monthly mean. Rainfall was about normal (70 to 140 percent of average) during the first 2 weeks of the month, except in southeastern Florida where rainfall was slightly below normal (50 to 70 percent of average). For the rest of June, rainfall was lower than normal (30 to 50 percent of average or lower in southeastern Florida). June monthly rainfall totals were slightly below average in much of southern Florida but substantially lower than average (30 to 55 percent) in the geographic areas of; eastern Palm Beach County, eastern Broward County, Water Conservation Area 1, and eastern Miami-Dade. Water levels in wells S-196A (fig. 4, Biscayne aquifer) and C-496 (fig. 6, water-table aquifer) rebounded gradually in the first half of the month, but declined once again in the last half of the month. By the end of June, water levels in well S-196A (fig. 4, Biscayne aquifer) had declined to two standard deviations below the normal monthly mean. Water levels in well PB-561 (fig. 5, surficial aquifer system), where rainfall was lower than average, decreased from slightly above to slightly below one standard deviation below normal monthly mean. Water levels in wells L-2194 (fig. 7, lower Tamiami aquifer) and L-729 (fig. 8, sandstone aquifer) increased from levels considerably below one standard deviation below normal monthly mean to about one standard deviation below normal monthly mean by the end of the month. Water levels in well L-2434 (fig. 10, lower Hawthorn producing zone), where rainfall was slightly below average, continued to show values considerably lower than one standard deviation below normal monthly mean.

July monthly rainfall totals were generally about average for southern Florida. Rainfall for the month generally varied spatially from 75 to 127 percent of average. Geographic areas that received more than 90 percent of the average rainfall were the east and west Everglades Agricultural Area (EAA), Water Conservation Areas 1, 2 and 3, Big Cypress Preserve, and eastern Broward. Rainfall in the eastern Miami-Dade geographic area was slightly above average (127 percent of average) for the period. Rainfall in southeastern Florida was lower than normal (30 to 50 percent of average) in the first week of the month. Rainfall in southwestern and south-central Florida was lower than normal (30 to 50 percent of average) in the second week of the month. Rainfall throughout southern Florida was higher than normal (140 to 200 percent of average) in the last week of the month. During July, water levels in most index wells increased. Water levels in well S-196A (fig. 4, Biscayne aquifer) increased from about two standard deviations below the normal monthly mean at the beginning of the month to about the normal monthly mean by the end of the month. Water levels in well C-496 (fig. 6, water-table aquifer) varied between the normal monthly mean and one standard deviation below the normal monthly mean. By the end of the month, water levels in well C-496 (fig. 6, water-table aquifer) were slightly above the normal monthly mean. Water levels in well L-729 (fig. 8, sandstone aquifer) increased from one standard deviation below the normal monthly mean at the beginning of the month to about the normal monthly mean by the end of the month.

August monthly rainfall totals for southeastern Florida were slightly above normal (99 to 135 percent of average). Rainfall in southeastern Florida was considerably greater than normal (200 to 330 percent of average) in the first week of the month, below normal (50 to 70 percent of average) in the second and third weeks of the month, and about normal (70 to 140 percent of average) in the last week of the month. August monthly rainfall totals for parts of southwestern and south-central Florida were considerably above average and ranged from 139 percent of normal in the East EAA geographic area to 171 percent of average in the east Caloosahatchee geographic area. Rainfall was greatest in the second week of the month and that can be attributed to Hurricane Charley which brought more than 5 inches of rain to Florida on August 13-14, 2004. In southwestern Florida, where monthly rainfall was 162 percent of average, water levels in well L-2194 (fig. 7, lower Tamiami aquifer) increased from about one standard deviation below the normal monthly mean at the beginning of the month to about one standard deviation above the normal monthly mean by the last week of the month. Water levels in well L-729 (fig. 8, sandstone aquifer) increased from about the normal monthly mean at the beginning of the month to about one standard deviation above the mean by the end of the month. Despite rainfall amounts that were considerably above average for southwestern Florida, water levels in well L-2434 (fig. 10, lower Hawthorn producing zone) decreased from about one standard deviation below normal mean at the beginning of the month to about two standard deviations below the normal monthly mean by the end of the month. In the eastern Miami-Dade geographic area, where rainfall was 99 percent of average, water levels in well S-196A (fig. 4, Biscayne aquifer) decreased from about one standard deviation above the normal monthly mean to about one standard deviation below the normal monthly mean by the third week of the month.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

September monthly rainfall totals varied spatially from 302 percent of average in the upper Kissimmee geographic area to 60 percent of average, in the Everglades National Park geographic area. Monthly rainfall totals were well above normal in the Martin (249 percent of average), eastern Palm Beach (208 percent of average) and lower Kissimmee (217 percent of average) geographic areas. This can be attributed to rainfall associated with Hurricanes Frances (September 5-6, 2004) and Jeanne (September 26-27, 2004), which produced 10 and 8 in., respectively, of rainfall in eastern, central, and northern Florida. Rainfall from Hurricane Frances caused water levels in well PB-561 (fig. 5, surficial aquifer system) to increase dramatically from about one standard deviation below the normal monthly mean to about one standard deviation above the normal monthly mean. Water levels increased again in response to rainfall from Hurricane Jeanne - from values slightly above the normal monthly mean on September 20, 2004, to values about two standard deviations above the normal monthly mean by September 26, 2004. Water levels in well S-196A (fig. 4, Biscayne aquifer) decreased from about the normal monthly mean to about one standard deviation below the normal monthly mean during the first 2 weeks of the month.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

EXPLANATION FOR PLOTS (FIGURES 4 TO 10) OF SUMMARY STATISTICS AND 2004 WATER YEAR DAILY MAXIMUM WATER LEVELS

Daily maximum water level, recorded during 2004 water year

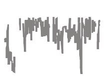
Monthly mean curve of daily maximum water levels collected, during the month displayed, for the October 1979 to September 2004 period.

One standard deviation (above or below) the monthly mean of daily maximum water levels collected, during the month displayed, for the October 1979 to September 2004 period.

EXPLANATION FOR PLOTS (FIGURES 4 TO 10) OF DAILY MAXIMUM WATER LEVELS, ANNUAL MEANS OF DAILY MAXIMUM WATER LEVELS, AND RESULTS OF THE SEASONAL KENDALL TREND TEST

Annual mean of daily maximum water levels collected, during the year displayed, for the October 1979 to September 2004 period, wherein no one month is missing more than 15 days of water level record

Annual mean of daily maximum water levels collected, during the year displayed, for the October 1979 to September 2004 period, wherein one or more months is missing 15 or more days of water level record.



Daily maximum water level. Breaks in line represent missing measurements, or measurements that failed quality assurance review.

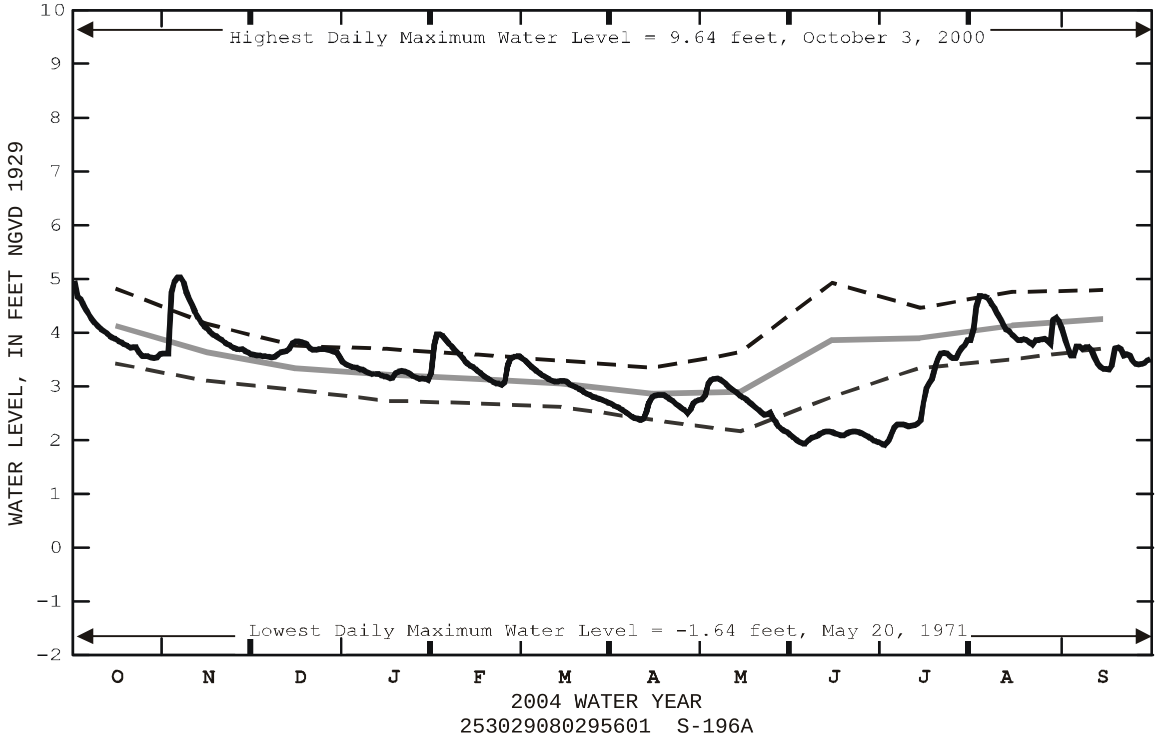
SKSE — The Seasonal Kendall Slope Estimator (SKSE) represents the median slope of the set of slopes obtained by computing the slope, in feet per year, of all unique pairs of monthly mean daily maximum water levels computed for the site shown.

p-value — The p-value represents a measure of the significance level of the Seasonal Kendall Trend Test statistic, computed concurrently with the SKSE, used to determine if there is a trend in the data examined. A p-value less than 0.05 indicates a statistically significant trend.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

LOWER EAST COAST - BISCAYNE AQUIFER

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

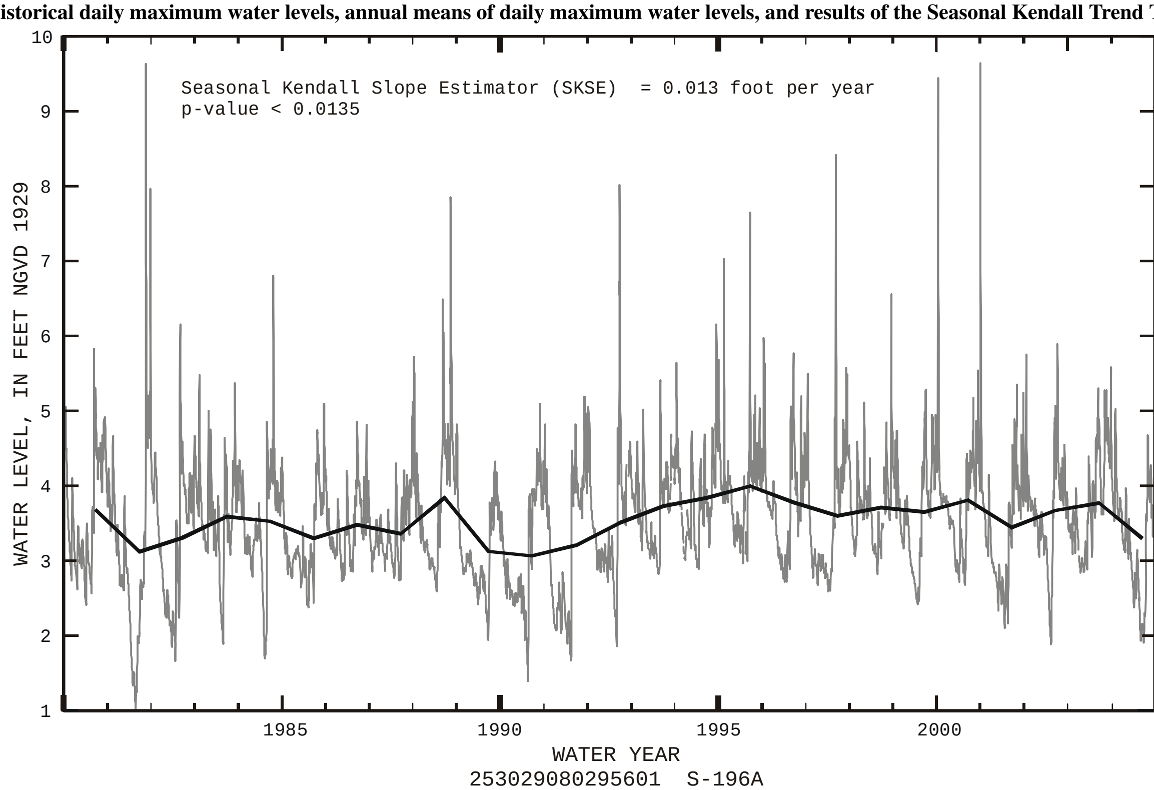


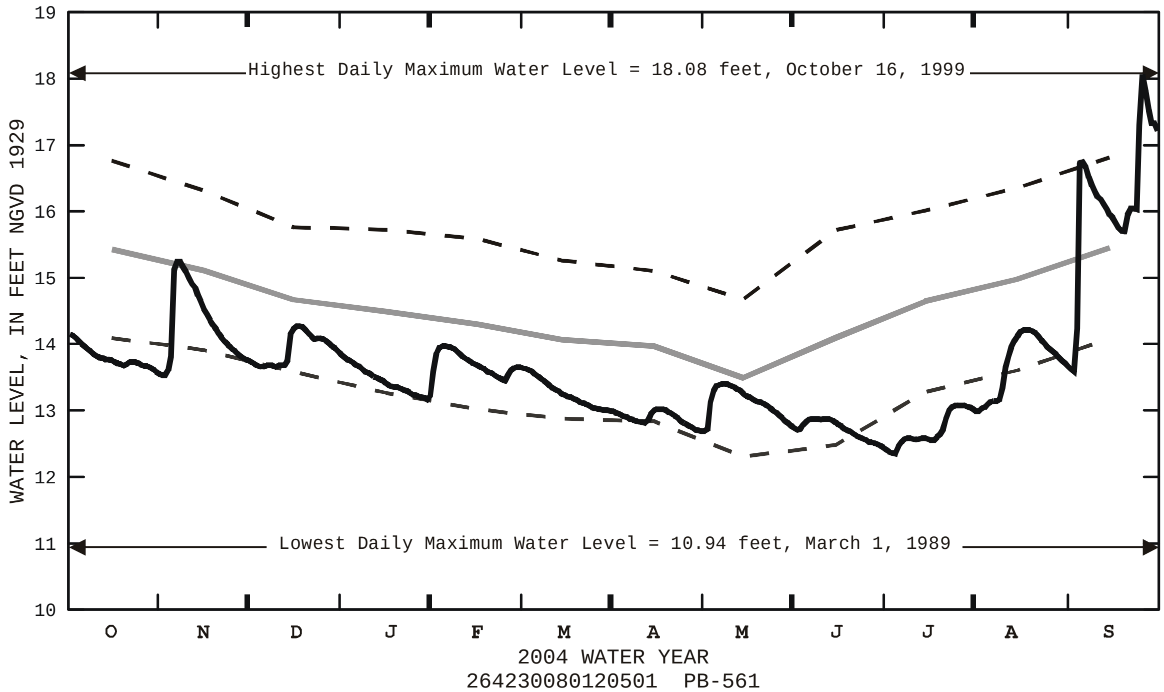
Figure 4. Historical water-level summary curves and annual mean of daily maximum water levels at well S-196A completed in the Biscayne aquifer in Miami-Dade County. Explanation of symbols and lines precedes figure 4.

VOLUME 2B: SOUTH FLORIDA

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

UPPER EAST COAST - SURFICIAL AQUIFER SYSTEM

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

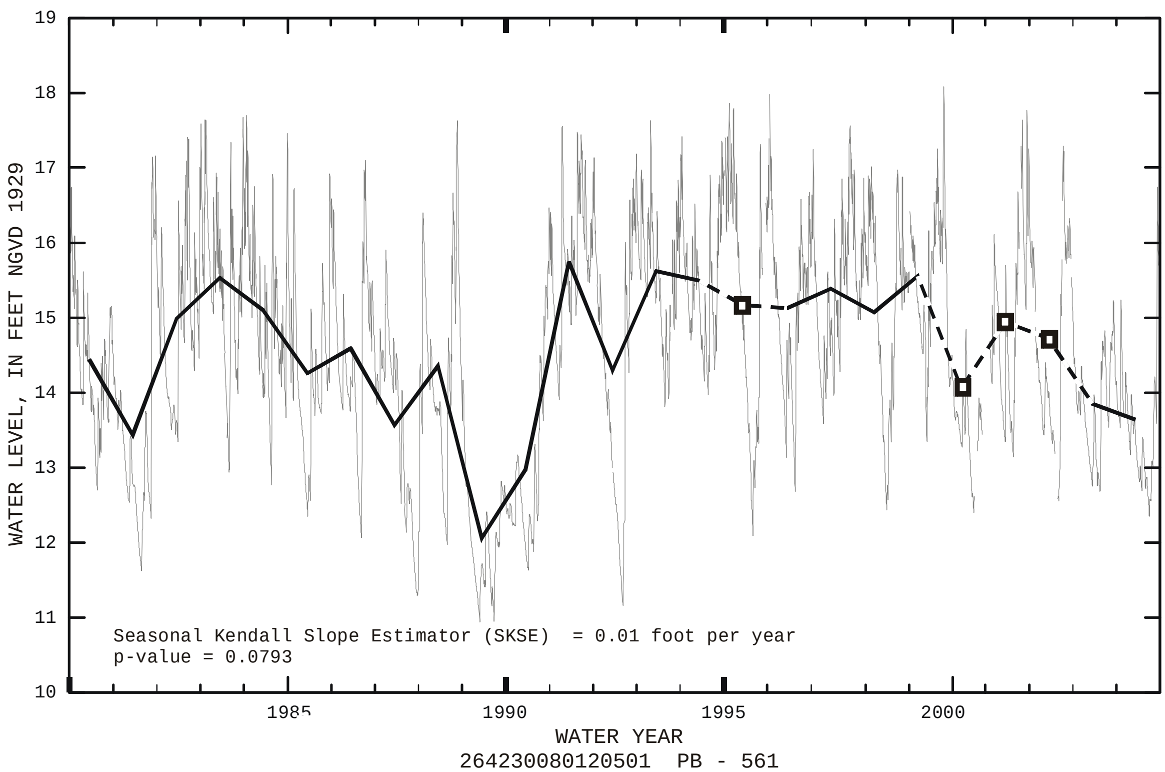
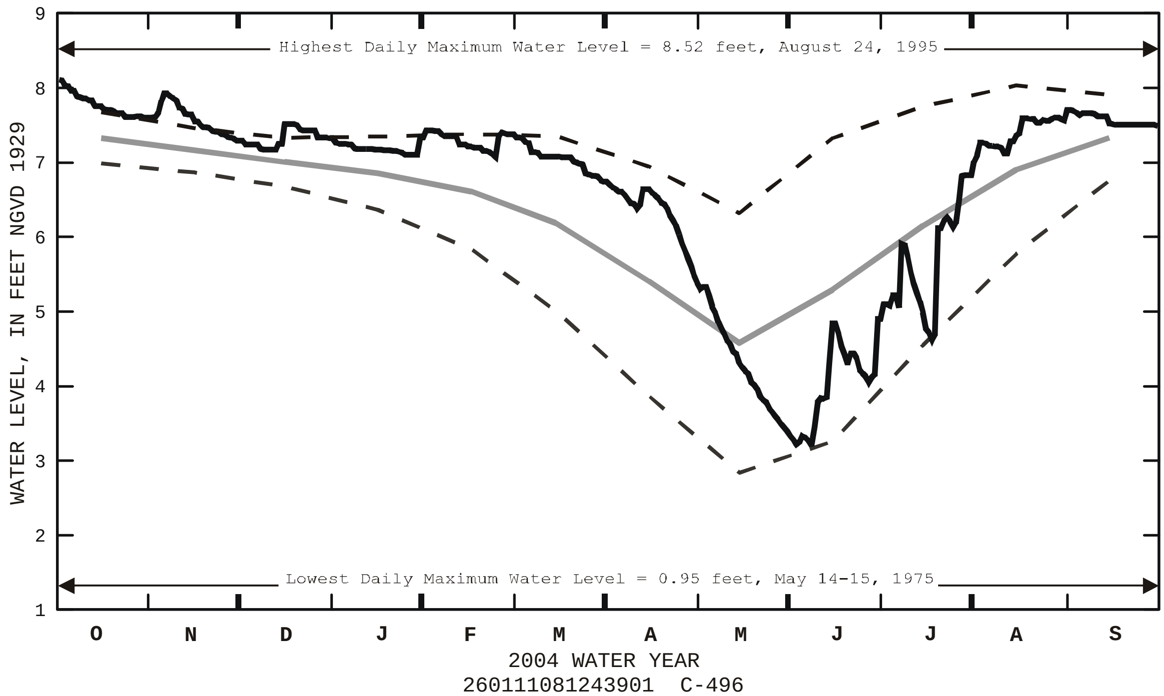


Figure 5. Historical water-level summary curves and annual mean of daily maximum water levels at well PB-561 completed in the surficial aquifer system in Palm Beach County. Explanation of symbols and lines precedes figure 4.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

LOWER WEST COAST - SURFICIAL AQUIFER

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

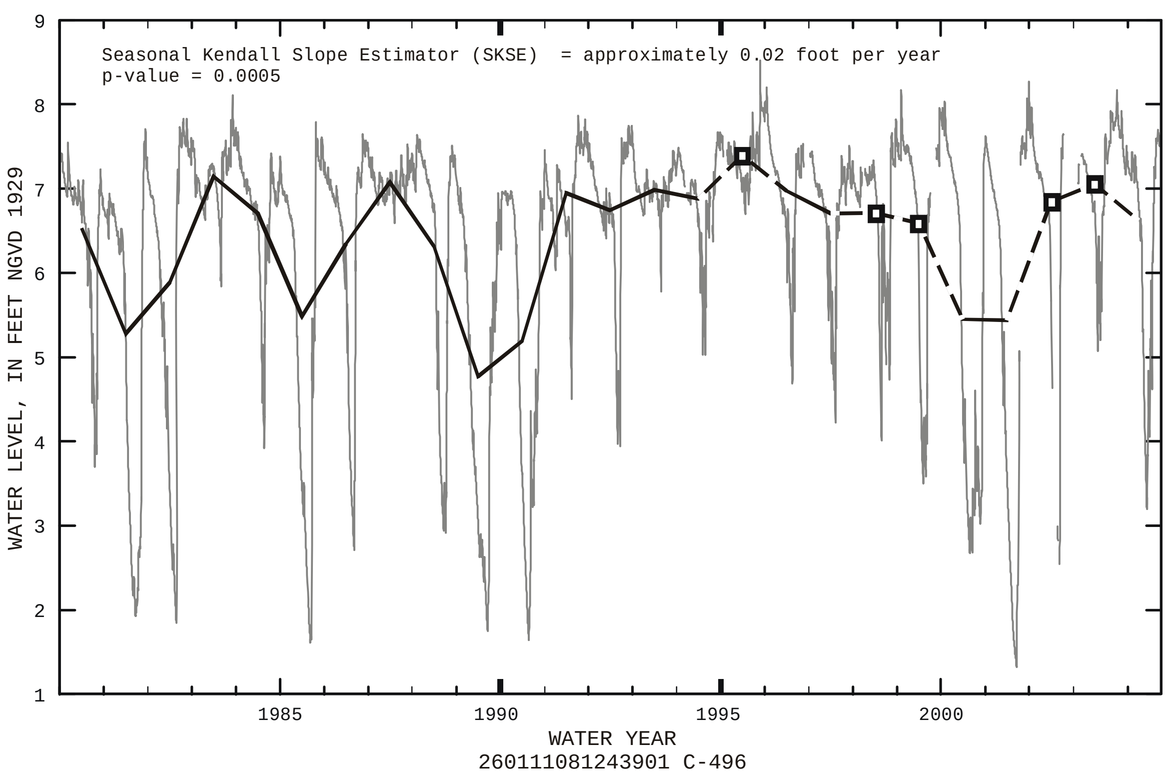
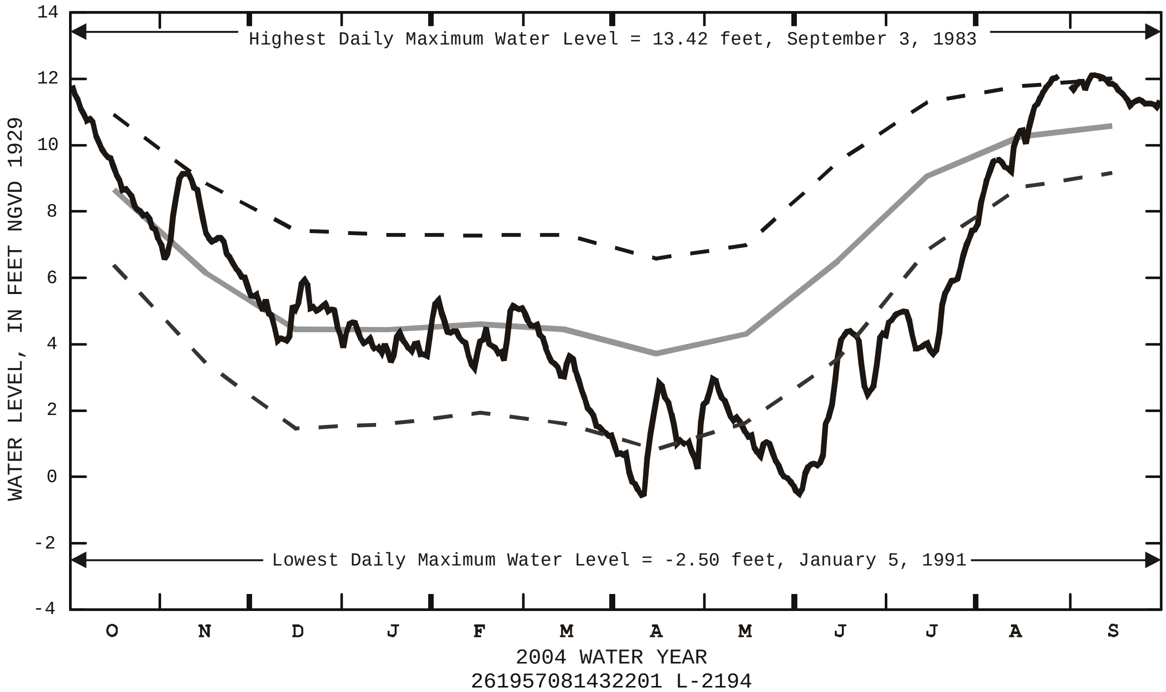


Figure 6. Historical water-level summary curves and annual mean of daily maximum water levels at well C-496 completed in the surficial aquifer system (water-table aquifer) in Collier County. Explanation of symbols and lines precedes figure 4.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

LOWER WEST COAST - LOWER TAMIAMI AQUIFER

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

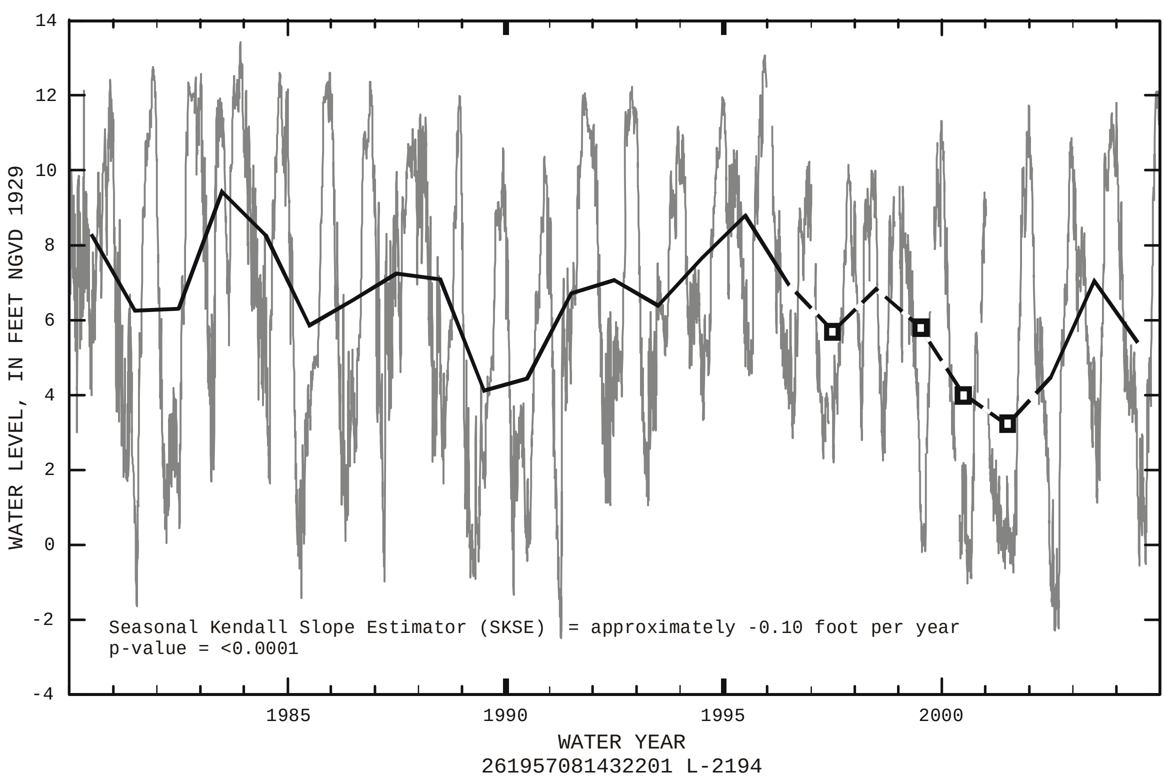
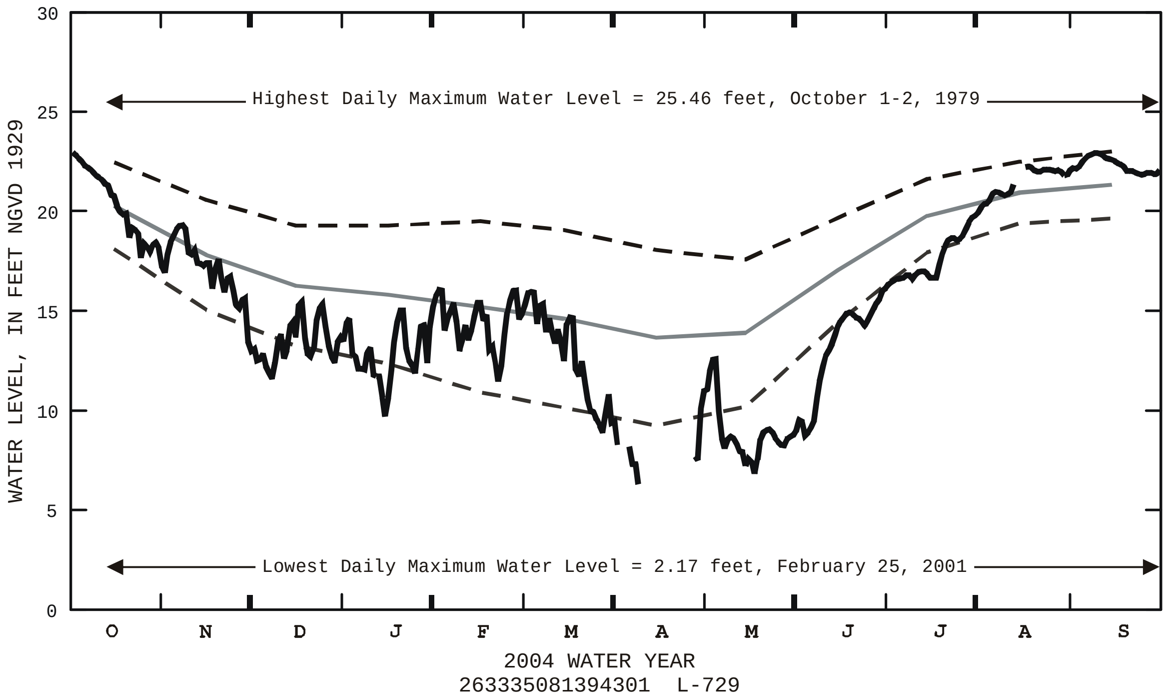


Figure 7. Historical water-level summary curves and annual mean of daily maximum water levels at well L-2194 completed in the lower Tamiami aquifer in Collier County. Explanation of symbols and lines precedes figure 4.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

LOWER WEST COAST - SANDSTONE AQUIFER

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

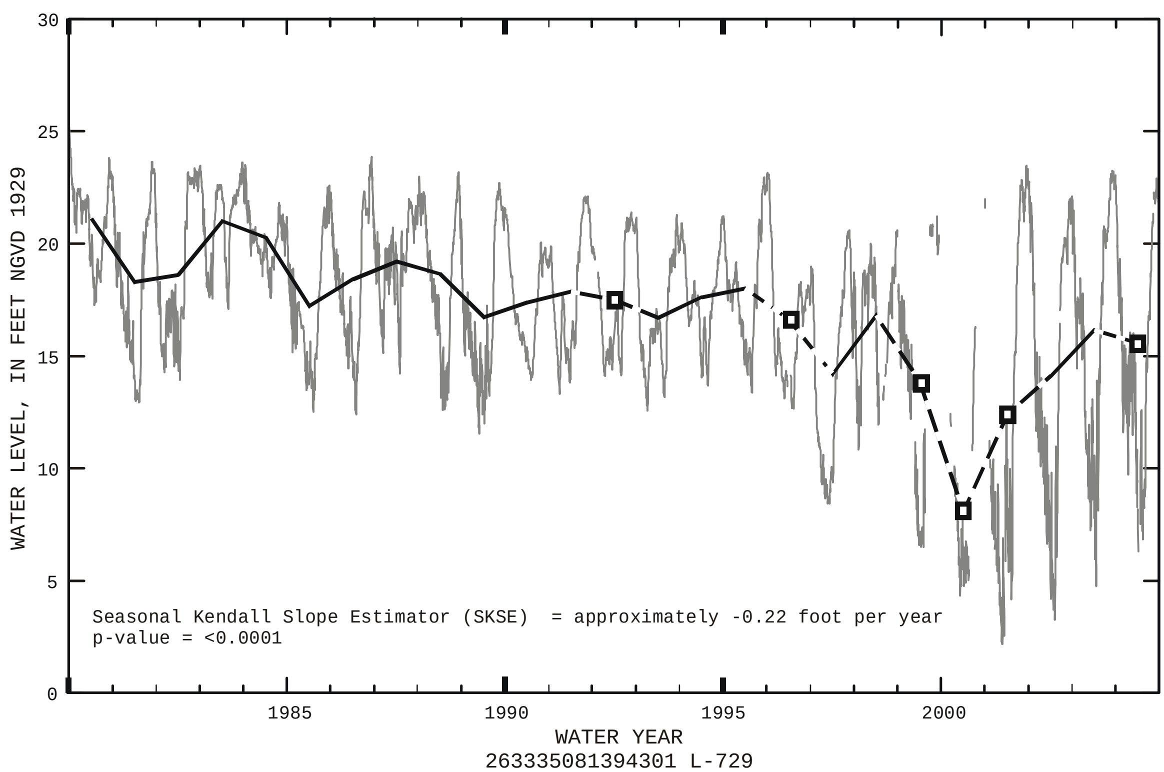
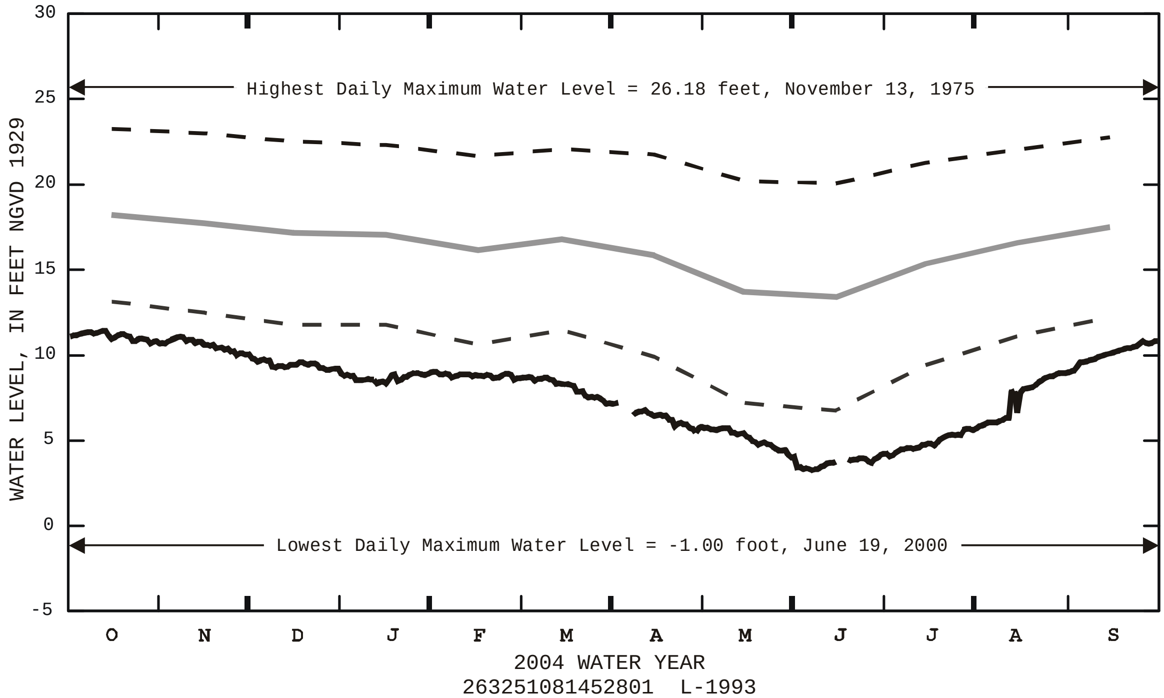


Figure 8. Historical water-level summary curves and annual mean of daily maximum water levels at well L-729 completed in the sandstone aquifer in Lee County. Explanation of symbols and lines precedes figure 4.

SUMMARY OF HYDROLOGIC CONDITIONS (continued)

LOWER WEST COAST - MID-HAWTHORN AQUIFER

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

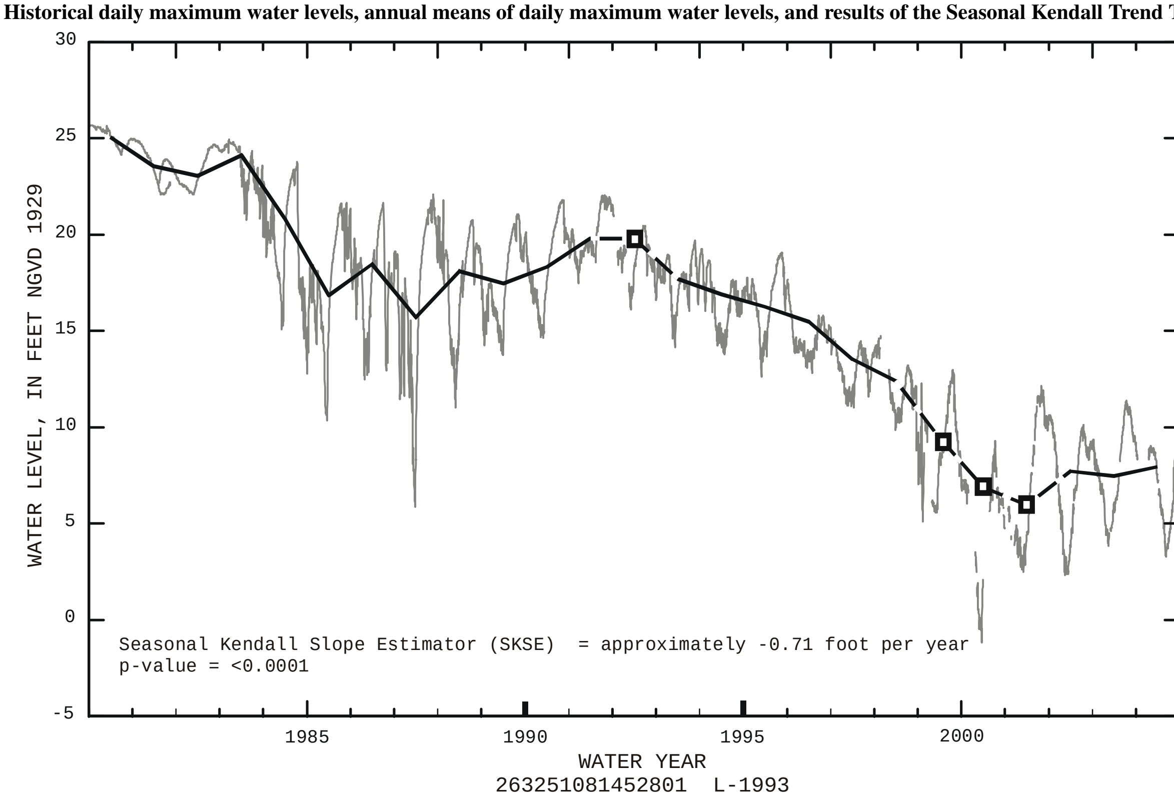
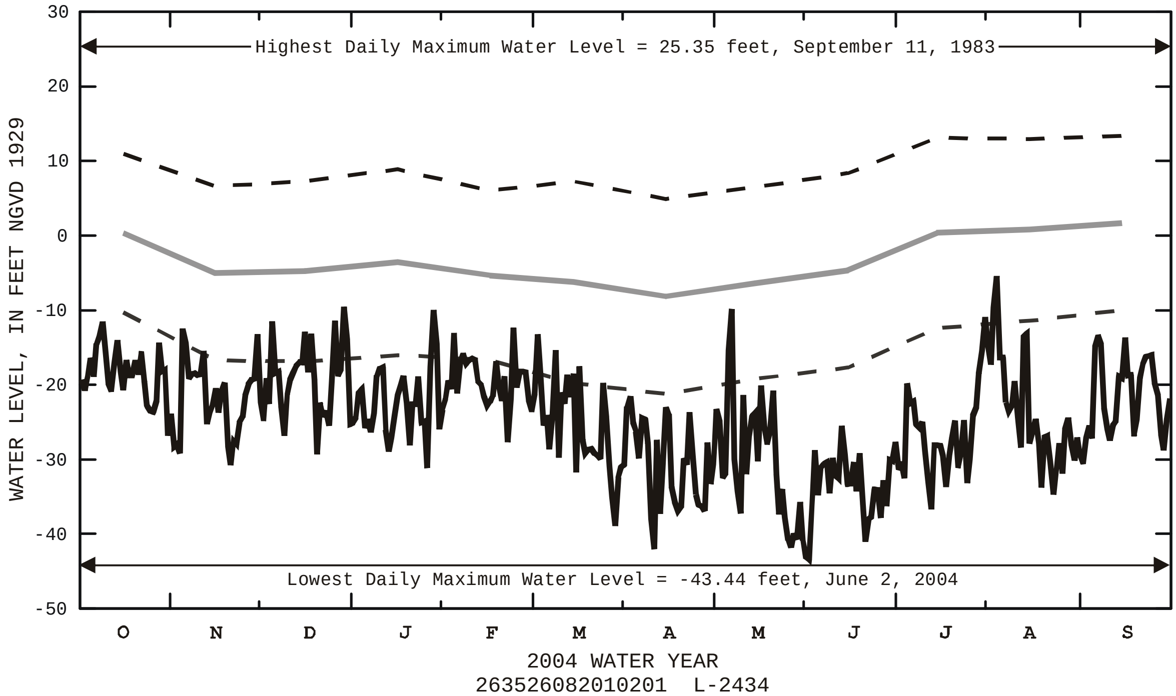


Figure 9. Historical water-level summary curves and annual mean of daily maximum water levels at well L-1993 completed in the mid-Hawthorn aquifer in Lee County. Explanation of symbols and lines precedes figure 4.

LOWER WEST COAST - LOWER HAWTHORN AQUIFER (LOWER HAWTHORN PRODUCING ZONE)

Historical water-level summary and observed daily maximum water levels, 2004 water year



Historical daily maximum water levels, annual means of daily maximum water levels, and results of the Seasonal Kendall Trend Test

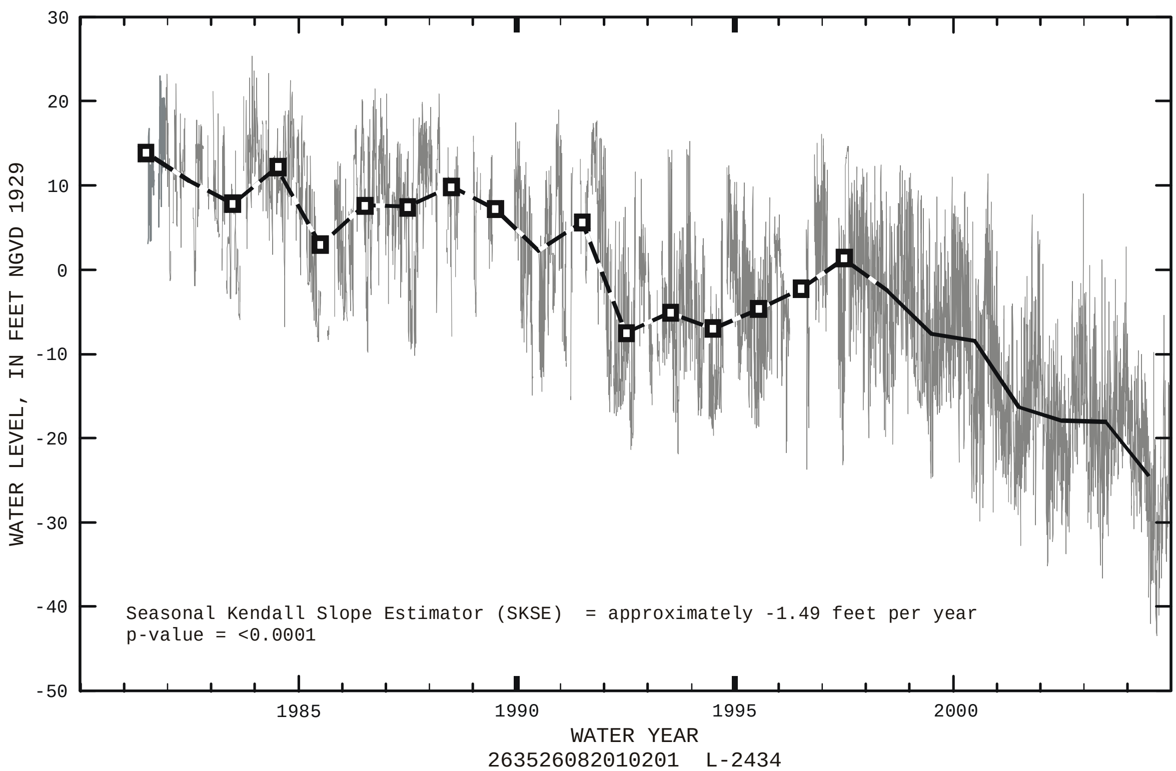


Figure 10. Historical water-level summary curves and annual mean of daily maximum water levels at well L-2434 completed in the lower Hawthorn producing zone in Lee County. Explanation of symbols and lines precedes figure.

SPECIAL NETWORKS AND PROGRAMS

Hydrologic Benchmark Network is a network of 61 sites in small drainage basins in 39 States that was established in 1963 to provide consistent streamflow data representative of undeveloped watersheds nationwide, and from which data could be analyzed on a continuing basis for use in comparison and contrast with conditions observed in basins more obviously affected by human activities. At selected sites, water-quality information is being gathered on major ions and nutrients, primarily to assess the effects of acid deposition on stream chemistry. Additional information on the Hydrologic Benchmark Program may be accessed from *http://water.usgs.gov/hbn/*.

National Stream-Quality Accounting Network (NASQAN) is a network of sites used to monitor the water quality of large rivers within the Nation's largest river basins. From 1995 through 1999, a network of approximately 40 stations was operated in the Mississippi, Columbia, Colorado, and Rio Grande River basins. For the period 2000 through 2004, sampling was reduced to a few index stations on the Colorado and Columbia Rivers so that a network of 5 stations could be implemented on the Yukon River. Samples are collected with sufficient frequency that the flux of a wide range of constituents can be estimated. The objective of NASQAN is to characterize the water quality of these large rivers by measuring concentration and mass transport of a wide range of dissolved and suspended constituents, including nutrients, major ions, dissolved and sediment-bound heavy metals, common pesticides, and inorganic and organic forms of carbon. This information will be used (1) to describe the long-term trends and changes in concentration and transport of these constituents; (2) to test findings of the National Water-Quality Assessment (NAWQA) Program; (3) to characterize processes unique to large-river systems such as storage and re-mobilization of sediments and associated contaminants; and (4) to refine existing estimates of off-continent transport of water, sediment, and chemicals for assessing human effects on the world's oceans and for determining global cycles of carbon, nutrients, and other chemicals. Additional information about the NASQAN Program may be accessed from *http://water.usgs.gov/nasqan/.*

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a network of monitoring sites that provides continuous measurement and assessment of the chemical constituents in precipitation throughout the United States. As the lead Federal agency, the USGS works together with over 100 organizations to provide a long-term, spatial and temporal record of atmospheric deposition generated from this network of 250 precipitation-chemistry monitoring sites. The USGS supports 74 of these 250 sites. This long-term, nationally consistent monitoring program, coupled with ecosystem research, provides critical information toward a national scorecard to evaluate the effectiveness of ongoing and future regulations intended to reduce atmospheric emissions and subsequent impacts to the Nation's land and water resources. Reports and other information on the NADP/NTN Program, as well as data from the individual sites, may be accessed from *http://bqs.usgs.gov/acidrain/.*

The USGS National Water-Quality Assessment (NAWQA) Program is a long-term program with goals to describe the status and trends of water-quality conditions for a large, representative part of the Nation's ground- and surface-water resources; to provide an improved understanding of the primary natural and human factors affecting these observed conditions and trends; and to provide information that supports development and evaluation of management, regulatory, and monitoring decisions by other agencies.

Assessment activities are being conducted in 42 study units (major watersheds and aquifer systems) that represent a wide range of environmental settings nationwide and that account for a large percentage of the Nation's water use. A wide array of chemical constituents is measured in ground water, surface water, streambed sediments, and fish tissues. The coordinated application of comparative hydrologic studies at a wide range of spatial and temporal scales will provide information for water-resources managers to use in making decisions and a foundation for aggregation and comparison of findings to address water-quality issues of regional and national interest.

Communication and coordination between USGS personnel and other local, State, and Federal interests are critical components of the NAWQA Program. Each study unit has a local liaison committee consisting of representatives from key Federal, State, and local water-resources agencies, Indian nations, and universities in the study unit. Liaison committees typically meet semiannually to discuss their information needs, monitoring plans and progress, desired information products, and opportunities to collaborate efforts among the agencies. Additional information about the NAWQA Program may be accessed from *http://water.usgs.gov/nawqa/.*

The USGS National Streamflow Information Program (NSIP) is a long-term program with goals to provide framework streamflow data across the Nation. Included in the program are creation of a permanent Federally funded streamflow network, research on the nature of streamflow, regional assessments of streamflow data and databases, and upgrades in the streamflow information delivery systems. Additional information about NSIP may be accessed from *http://water.usgs.gov/nsip/.*

EXPLANATION OF THE RECORDS

A calendar of the water year is provided on the inside of the front cover. The records contain streamflow data, stage and content data for lakes and reservoirs, water-quality data for surface and ground water, and ground-water level data. The following sections of the introductory text are presented to provide users with a more detailed explanation of how the hydrologic data published in this report were collected, analyzed, computed, and arranged for presentation.

Station Identification Numbers

Each data station, whether streamsite or well, in this report is assigned a unique identification number. The number usually is assigned when a station is first established and is retained for that station indefinitely. The systems used by the U.S. Geological Survey to assign identification numbers for surface-water stations and for ground-water well sites differ, but both are based on geographic location. The "downstream order" system is used for regular surface-water stations and the "latitude-longitude" system is used for wells and for surface-water stations where only miscellaneous observations are made.

Downstream Order and Station Number

Since October 1, 1950, hydrologic-station records in USGS reports have been listed in order of downstream direction along the main stream. All stations on a tributary entering upstream from a main-stream station are listed before that station. A station on a tributary entering between two main-stream stations is listed between those stations. A similar order is followed in listing stations on first rank, second rank, and other ranks of tributaries. The rank of any tributary on which a station is located with respect to the stream to which it is immediately tributary is indicated by an indention in that list of stations in the front of this report. Each indentation represents one rank. This downstream order and system of indentation indicates which stations are on tributaries between any two stations and the rank of the tributary on which each station is located.

As an added means of identification, each hydrologic station and partial-record station has been assigned a station number. These station numbers are in the same downstream order used in this report. In assigning a station number, no distinction is made between partial-record stations and other stations; therefore, the station number for a partial-record station indicates downstream-order position in a list composed of both types of stations. Gaps are consecutive. The complete eight-digit (or 10-digit) number for each station, such as 02228500, which appears just to the left of the station name, includes the 2-digit part number "02" plus the 6- to 12-digit downstream-order number "228500." The part number designates the major river basin; for example, part "02" is the South Atlantic Slope and eastern Gulf of Mexico basins. In areas of high station density, an additional two digits may be added to the station identification number to yield a 10-digit number. The stations are numbered in downstream order as described above between stations of consecutive 8-digit numbers.

Numbering System for Wells and Miscellaneous Sites

The USGS well and miscellaneous site-numbering system is based on the grid system of latitude and longitude. The system provides the geographic location of the well or miscellaneous site and a unique number for each site. The number consists of 15 digits. The first 6 digits denote the degrees, minutes, and seconds of latitude, and the next 7 digits denote degrees, minutes, and seconds of longitude; the last 2 digits are a sequential number for wells within a 1-second grid. In the event that the latitude-longitude coordinates for a well and miscellaneous site are the same, a sequential number such as "01," "02," and so forth, would be assigned as one would for wells (see fig. 11). The 8-digit, downstream order station numbers are not assigned to wells and miscellaneous sites where only random water-quality samples or discharge measurements are taken.

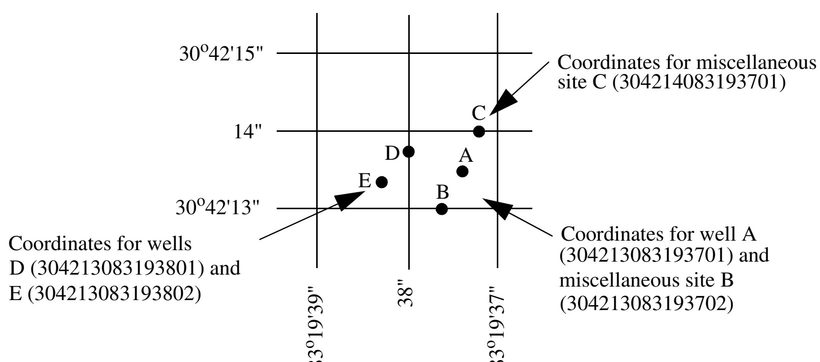


Figure 11. System for numbering wells and miscellaneous sites. (latitude and longitude)

EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS

Records of stage and water discharge may be complete or partial. Complete records of discharge are those obtained using a stage-recording device through which either instantaneous or mean daily discharges may be computed for any time, or any period of time, during the period of record. Complete records of lake elevation, similarly, are those for which stage may be computed or estimated with reasonable accuracy for any time, or period of time. They may be obtained using a stage-recording device or daily or weekly observations, but need not be. Because daily mean discharges and lake elevations commonly are published for such stations, they are referred to as “daily stations.”

By contrast, partial records are obtained through discrete measurements without using a continuous stage- recording device and pertain only to a few flow characteristics, or perhaps only one. The nature of the partial record is indicated by table titles such as “Crest-stage partial records,” or “Low-flow partial records.” Records of miscellaneous discharge measurements or of measurements from special studies, such as low-flow seepage studies, may be considered as partial records, but they are presented separately in this report.

Location of all complete-record and partial-record stations for which data are given in this report are shown in figures preceding each sub-basin.

Data Collection and Computation

The base data collected at gaging stations consist of records of stage and measurements of discharge of streams or canals, and stage, surface area, and volume of lakes or reservoirs. In addition, observations of factors affecting the stage-discharge relation or the stage-capacity relation, weather records, and other information are used to supplement base data in determining the daily flow or volume of water in storage. Records of stage are obtained from a water-stage recorder that is either downloaded electronically in the field to a laptop computer or similar device or is transmitted using telemetry such as GOES satellite, land-line or cellular-phone modems, or by radio transmission. Measurements of discharge are made with a current meter or acoustic Doppler current profiler, using the general methods adopted by the USGS. These methods are described in standard textbooks, USGS Water-Supply Paper 2175, and the Techniques of Water-Resources Investigations of the United States Geological Survey (TWRIs), Book 3, Chapters A1 through A19 and Book 8, Chapters A2 and B2, which may be accessed from *http://water.usgs.gov/pubs/twri/*. The methods are consistent with the American Society for Testing and Materials (ASTM) standards and generally follow the standards of the International Organization for Standards (ISO).

For stream-gaging stations, discharge-rating tables for any stage are prepared from stage-discharge curves. If extensions to the rating curves are necessary to express discharge greater than measured, the extensions are made on the basis of indirect measurements of peak discharge (such as slope-area or contracted-opening measurements, or computation of flow over dams and weirs), step-backwater techniques, velocity-area studies, and logarithmic plotting. The daily mean discharge is computed from gage heights and rating tables, then the monthly and yearly mean discharges are computed from the daily values. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features of the stream channel, the daily mean discharge is computed by the shifting-control method in which correction factors based on individual discharge measurements and notes by engineers and observers are used when applying the gage heights to the rating tables. If the stage-discharge relation for a station is temporarily changed by the presence of aquatic growth or debris on the controlling section, the daily mean discharge is computed by the shifting-control method.

The stage-discharge relation at some stream-gaging stations is affected by backwater from reservoirs, tributary streams, or other sources. Such an occurrence necessitates the use of the slope method in which the slope or fall in a reach of the stream is a factor in computing discharge. The slope or fall is obtained by means of an auxiliary gage at some distance from the base gage.

An index velocity is measured using ultrasonic or acoustic instruments at some stream-gaging stations and this index velocity is used to calculate an average velocity for the flow in the stream. This average velocity along with a stage-area relation is then used to calculate average discharge.

At some stations, stage-discharge relation is affected by changing stage. At these stations, the rate of change in stage is used as a factor in computing discharge.

At some stream-gaging stations in the northern United States, the stage-discharge relation is affected by ice in the winter; therefore, computation of the discharge in the usual manner is impossible. Discharge for periods of ice effect is computed on the basis of gage-height record and occasional winter-discharge measurements. Consideration is given to the available information on temperature and precipitation, notes by gage observers and hydrologists, and comparable records of discharge from other stations in the same or nearby basins.

For a lake or reservoir station, capacity tables giving the volume or contents for any stage are prepared from stage-area relation curves defined by surveys. The application of the stage to the capacity table gives the contents, from which the daily, monthly, or yearly changes are computed.

If the stage-capacity curve is subject to changes because of deposition of sediment in the reservoir, periodic resurveys of the reservoir are necessary to define new stage-capacity curves. During the period between reservoir surveys, the computed contents may be increasingly in error due to the gradual accumulation of sediment.

For some stream-gaging stations, periods of time occur when no gage-height record is obtained or the recorded gage height is faulty and cannot be used to compute daily discharge or contents. Such a situation can happen when the recorder stops or otherwise fails to operate properly, the intakes are plugged, the float is frozen in the well, or for various other reasons. For such periods, the daily discharges are estimated on the basis of recorded range in stage, prior and subsequent records, discharge measurements, weather records, and comparison with records from other stations in the same or nearby basins. Likewise, lake or reservoir volumes may be estimated on the basis of operator’s log, prior and subsequent records, inflow-outflow studies, and other information.

Data Presentation

The records published for each continuous-record surface-water discharge station (stream-gaging station) consist of five parts: (1) the station manuscript or description; (2) the data table of daily mean values of discharge for the current water year with summary data; (3) a tabular statistical summary of monthly mean flow data for a designated period, by water year; (4) a summary statistics table that includes statistical data of annual, daily, and instantaneous flows as well as data pertaining to annual runoff, 7-day low-flow minimums, and flow duration; and (5) a hydrograph of discharge.

Station Manuscript

The manuscript provides, under various headings, descriptive information, such as station location; period of record; historical extremes outside the period of record; record accuracy; and other remarks pertinent to station operation and regulation. The following information, as appropriate, is provided with each continuous record of discharge or lake content. Comments follow that clarify information presented under the various headings of the station description.

LOCATION.—Location information is obtained from the most accurate maps available. The location of the gaging station with respect to the cultural and physical features in the vicinity and with respect to the reference place mentioned in the station name is given. River mileages, given for only a few stations, were determined by methods given in "River Mileage Measurement," Bulletin 14, Revision of October 1968, prepared by the Water Resources Council or were provided by the U.S. Army Corps of Engineers.

DRAINAGE AREA.—Drainage areas are measured using the most accurate maps available. Because the type of maps available varies from one drainage basin to another, the accuracy of drainage areas likewise varies. Drainage areas are updated as better maps become available.

PERIOD OF RECORD.—This term indicates the time period for which records have been published for the station or for an equivalent station. An equivalent station is one that was in operation at a time that the present station was not and whose location was such that its flow reasonably can be considered equivalent to flow at the present station.

REVISED RECORDS.—If a critical error in published records is discovered, a revision is included in the first report published following discovery of the error.

GAGE.—The type of gage in current use, the datum of the current gage referred to a standard datum, and a condensed history of the types, locations, and datums of previous gages are given under this heading.

REMARKS.—All periods of estimated daily discharge either will be identified by date in this paragraph of the station description for water-discharge stations or flagged in the daily discharge table. (See section titled Identifying Estimated Daily Discharge.) Information is presented relative to the accuracy of the records, to special methods of computation, and to conditions that affect natural flow at the station. In addition, information may be presented pertaining to average discharge data for the period of record; to extremes data for the period of record and the current year; and, possibly, to other pertinent items. For reservoir stations, information is given on the dam forming the reservoir, the capacity, the outlet works and spillway, and the purpose and use of the reservoir.

COOPERATION.—Records provided by a cooperating organization or obtained for the USGS by a cooperating organization are identified here.

EXTREMES OUTSIDE PERIOD OF RECORD.—Information here documents major floods or unusually low flows that occurred outside the stated period of record. The information may or may not have been obtained by the USGS.

REVISIONS.—Records are revised if errors in published records are discovered. Appropriate updates are made in the USGS distributed data system, NWIS, and subsequently to its Web-based National data system, NWISWeb (*http://water.usgs.gov/nwis/nwis*). Users are encouraged to obtain all required data from NWIS or NWISWeb to ensure that they have the most recent data updates. Updates to NWISWeb are made on an annual basis.

Although rare, occasionally the records of a discontinued gaging station may need revision. Because no current or, possibly, future station manuscript would be published for these stations to document the revision in a REVISED RECORDS entry, users of data for these stations who obtained the record from previously published data reports may wish to contact the District Office (address given on the back of the title page of this report) to determine if the published records were revised after the station was discontinued. If, however, the data for a discontinued station were obtained by computer retrieval, the data would be current. Any published revision of data is always accompanied by revision of the corresponding data in computer storage.

Manuscript information for lake or reservoir stations differs from that for stream stations in the nature of the REMARKS and in the inclusion of a stage-capacity table when daily volumes are given.

Peak Discharge Greater than Base Discharge

Tables of peak discharge above base discharge are included for some stations where secondary instantaneous peak discharge data are used in flood-frequency studies of highway and bridge design, flood-control structures, and other flood-related projects. The base discharge value is selected so an average of three peaks a year will be reported. This base discharge value has a recurrence interval of approximately 1.1 years or a 91-percent chance of exceedence in any 1 year.

Data Table of Daily Mean Values

The daily table of discharge records for stream-gaging stations gives mean discharge for each day of the water year. In the monthly summary for the table, the line headed TOTAL gives the sum of the daily figures for each month; the line headed MEAN gives the arithmetic average flow in cubic feet per second for the month; and the lines headed MAX and MIN give the maximum and minimum daily mean discharges, respectively, for each month. Discharge for the month is expressed in cubic feet per second per square mile (line headed CFSM); or in inches (line headed IN); or in acre-feet (line headed AC-FT). Values for cubic feet per second per square mile and runoff in inches or in acre-feet may be omitted if extensive regulation or diversion is in effect or if the drainage area includes large noncontributing areas. At some stations, monthly and (or) yearly observed discharges are adjusted for reservoir storage or diversion, or diversion data or reservoir volumes are given. These values are identified by a symbol and a corresponding footnote.

Statistics of Monthly Mean Data

A tabular summary of the mean (line headed MEAN), maximum (MAX), and minimum (MIN) of monthly mean flows for each month for a designated period is provided below the mean values table. The water years of the first occurrence of the maximum and minimum monthly flows are provided immediately below those values. The designated period will be expressed as FOR WATER YEARS __-__, BY WATER YEAR (WY), and will list the first and last water years of the range of years selected from the PERIOD OF RECORD paragraph in the station manuscript. The designated period will consist of all of the station record within the specified water years, including complete months of record for partial water years, and may coincide with the period of record for the station. The water years for which the statistics are computed are consecutive, unless a break in the station record is indicated in the manuscript.

Summary Statistics

A table titled SUMMARY STATISTICS follows the statistics of monthly mean data tabulation. This table consists of four columns with the first column containing the line headings of the statistics being reported. The table provides a statistical summary of yearly, daily, and instantaneous flows, not only for the current water year but also for the previous calendar year and for a designated period, as appropriate. The designated period selected, WATER YEARS __-__, will consist of all of the station records within the specified water years, including complete months of record for partial water years, and may coincide with the period of record for the station.

The water years for which the statistics are computed are consecutive, unless a break in the station record is indicated in the manuscript. All of the calculations for the statistical characteristics designated ANNUAL (see line headings below), except for the ANNUAL 7-DAY MINIMUM statistic, are calculated for the designated period using complete water years. The other statistical characteristics may be calculated using partial water years.

The date or water year, as appropriate, of the first occurrence of each statistic reporting extreme values of discharge is provided adjacent to the statistic. Repeated occurrences may be noted in the REMARKS paragraph of the manuscript or in footnotes. Because the designated period may not be the same as the station period of record published in the manuscript, occasionally the dates of occurrence listed for the daily and instantaneous extremes in the designated-period column may not be within the selected water years listed in the heading. When the dates of occurrence do not fall within the selected water years listed in the heading, it will be noted in the REMARKS paragraph or in footnotes. Selected streamflow duration-curve statistics and runoff data also are given. Runoff data may be omitted if extensive regulation or diversion of flow is in effect in the drainage basin.

The following summary statistics data are provided with each continuous record of discharge. Comments that follow clarify information presented under the various line headings of the SUMMARY STATISTICS table.

ANNUAL TOTAL.—The sum of the daily mean values of discharge for the year.

ANNUAL MEAN.—The arithmetic mean for the individual daily mean discharges for the year noted or for the designated period.

HIGHEST ANNUAL MEAN.—The maximum annual mean discharge occurring for the designated period.

LOWEST ANNUAL MEAN.—The minimum annual mean discharge occurring for the designated period.

HIGHEST DAILY MEAN.—The maximum daily mean discharge for the year or for the designated period.

LOWEST DAILY MEAN.—The minimum daily mean discharge for the year or for the designated period.

ANNUAL 7-DAY MINIMUM.—The lowest mean discharge for 7 consecutive days for a calendar year or a water year. Note that most low-flow frequency analyses of annual 7-day minimum flows use a climatic year (April 1-March 31). The date shown in the summary statistics table is the initial date of the 7-day period. This value should not be confused with the 7-day 10-year low-flow statistic.

MAXIMUM PEAK FLOW.—The maximum instantaneous peak discharge occurring for the water year or designated period. Occasionally the maximum flow for a year may occur at midnight at the beginning or end of the year, on a recession from or rise toward a higher peak in the adjoining year. In this case, the maximum peak flow is given in the table and the maximum flow may be reported in a footnote or in the REMARKS paragraph in the manuscript.

MAXIMUM PEAK STAGE.—The maximum instantaneous peak stage occurring for the water year or designated period. Occasionally the maximum stage for a year may occur at midnight at the beginning or end of the year, on a recession from or rise toward a higher peak in the adjoining year. In this case, the maximum peak stage is given in the table and the maximum stage may be reported in the REMARKS paragraph in the manuscript or in a footnote. If the dates of occurrence of the maximum peak stage and maximum peak flow are different, the REMARKS paragraph in the manuscript or a footnote may be used to provide further information.

INSTANTANEOUS LOW FLOW.—The minimum instantaneous discharge occurring for the water year or for the designated period.

ANNUAL RUNOFF.—Indicates the total quantity of water in runoff for a drainage area for the year. Data reports may use any of the following units of measurement in presenting annual runoff data:

> Acre-foot (AC-FT) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.
>
> Cubic feet per square mile (CFSM) is the average number of cubic feet of water flowing per second from each square mile of area drained, assuming the runoff is distributed uniformly in time and area.
>
> Inches (INCHES) indicate the depth to which the drainage area would be covered if all of the runoff for a given time period were uniformly distributed on it.

10 PERCENT EXCEEDS.—The discharge that has been exceeded 10 percent of the time for the designated period.

50 PERCENT EXCEEDS.—The discharge that has been exceeded 50 percent of the time for the designated period.

90 PERCENT EXCEEDS.—The discharge that has been exceeded 90 percent of the time for the designated period.

Data collected at partial-record stations follow the information for continuous-record sites. Data for partial-record discharge stations are presented in two tables. The first table lists annual maximum stage and discharge at crest-stage stations, and the second table lists discharge measurements at low-flow partial-record stations. The tables of partial-record stations are followed by a listing of discharge measurements made at sites other than continuous-record or partial-record stations. These measurements are often made in times of drought or flood to give better areal coverage to those events. Those measurements and others collected for a special reason are called measurements at miscellaneous sites.

Identifying Estimated Daily Discharge

Estimated daily-discharge values published in the water-discharge tables of annual State data reports are identified. This identification is shown either by flagging individual daily values with the letter “e” and noting in a table footnote, “e–Estimated,” or by listing the dates of the estimated record in the REMARKS paragraph of the station description.

Accuracy of Field Data and Computed Results

The accuracy of streamflow data depends primarily on (1) the stability of the stage-discharge relation or, if the control is unstable, the frequency of discharge measurements, and (2) the accuracy of observations of stage, measurements of discharge, and interpretations of records.

The degree of accuracy of the records is stated in the REMARKS in the station description. “Excellent” indicates that about 95 percent of the daily discharges are within 5 percent of the true value; “good” within 10 percent; and “fair,” within 15 percent. “Poor” indicates that daily discharges have less than “fair” accuracy. Different accuracies may be attributed to different parts of a given record.

Values of daily mean discharge in this report are shown to the nearest hundredth of a cubic foot per second for discharges of less than 1 ft^3/s; to the nearest tenths between 1.0 and 10 ft^3/s; to whole numbers between 10 and 1,000 ft^3/s; and to 3 significant figures above 1,000 ft^3/s. The number of significant figures used is based solely on the magnitude of the discharge value. The same rounding rules apply to discharge values listed for partial-record stations.

Discharge at many stations, as indicated by the monthly mean, may not reflect natural runoff due to the effects of diversion, consumption, regulation by storage, increase or decrease in evaporation due to artificial causes, or to other factors. For such stations, values of cubic feet per second per square mile and of runoff in inches are not published unless satisfactory adjustments can be made for diversions, for changes in contents of reservoirs, or for other changes incident to use and control. Evaporation from a reservoir is not included in the adjustments for changes in reservoir contents, unless it is so stated. Even at those stations where adjustments are made, large errors in computed runoff may occur if adjustments or losses are large in comparison with the observed discharge.

Other Data Records Available

Information of a more detailed nature than that published for most of the stream-gaging stations such as discharge measurements, gage-height records, and rating tables is available from the Florida Integrated Science Center - Water and Restoration Studies (FISC-WRS). Also, most stream-gaging station records are available in computer-usable form and many statistical analyses have been made.

Information on the availability of unpublished data or statistical analyses may be obtained from the FISC-WRS. (see address that is shown on the back of the title page of this report).

EXPLANATION OF PRECIPITATION RECORDS

Data Collection and Computation

Rainfall data generally are collected using electronic data loggers that measure the rainfall in 0.01-inch increments every 15 minutes using either a tipping-bucket rain gage or a collection well gage. Twenty-four hour rainfall totals are tabulated and presented. A 24-hour period extends from just past midnight of the previous day to midnight of the current day. Snowfall-affected data can result during cold weather when snow fills the rain-gage funnel and then melts as temperatures rise. Snowfall-affected data are subject to errors. Missing values are indicated by this symbol “---” in the table.

Data Presentation

Precipitation records collected at surface-water gaging stations are identified with the same station number and name as the stream-gaging station. Where a surface-water daily-record station is not available, the precipitation record is not published, but is available in the files of the U.S. Geological Survey.

Information pertinent to the history of a precipitation station is provided in descriptive headings preceding the tabular data. These descriptive headings give details regarding location, period of record, and general remarks.

The following information is provided with each precipitation station. Comments that follow clarify information presented under the various headings of the station description.

LOCATION.—See Data Presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

PERIOD OF RECORD.—See Data Presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

INSTRUMENTATION.—Information on the type of rainfall collection system is given.

REMARKS.—Remarks provide added information pertinent to the collection, analysis, or computation of records.

EXPLANATION OF WATER-QUALITY RECORDS

Collection and Examination of Data

Surface-water samples for analysis usually are collected at or near stream-gaging stations. The quality-of-water records are given immediately following the discharge records at these stations.

The descriptive heading for water-quality records gives the period of record for all water-quality data; the period of daily record for parameters that are measured on a daily basis (specific conductance, water temperature, sediment discharge, and so forth); extremes for the current year; and general remarks.

For ground-water records, no descriptive statements are given; however, the well number, depth of well, sampling date, or other pertinent data are given in the table containing the chemical analyses of the ground water.

Water Analysis

Most of the methods used for collecting and analyzing water samples are described in the TWRIs, which may be accessed from http://water.usgs.gov/pubs/twri/.

One sample can define adequately the water quality at a given time if the mixture of solutes throughout the stream cross-section is homogeneous. However, the concentration of solutes at different locations in the cross section may vary widely with different rates of water discharge, depending on the source of material and the turbulence and mixing of the stream. Some streams must be sampled at several verticals to obtain a representative sample needed for an accurate mean concentration and for use in calculating load.

Chemical-quality data published in this report are considered to be the most representative values available for the stations listed. The values reported represent water-quality conditions at the time of sampling as much as possible, consistent with available sampling techniques and methods of analysis. In the rare case where an apparent inconsistency exists between a reported pH value and the relative abundance of carbon dioxide species (carbonate and bicarbonate), the inconsistency is the result of a slight uptake of carbon dioxide from the air by the sample between measurement of pH in the field and determination of carbonate and bicarbonate in the laboratory.

For chemical-quality stations equipped with digital monitors, the records consist of daily maximum and minimum values (and sometimes mean or median values) for each constituent measured, and are based on 15-minute or 1-hour intervals of recorded data beginning at 0000 hours and ending at 2400 hours for the day of record.

SURFACE-WATER-QUALITY RECORDS

Records of surface-water quality ordinarily are obtained at or near stream-gaging stations because discharge data are useful in the interpretation of surface-water quality. Records of surface-water quality in this report involve a variety of types of data and measurement frequencies.

Classification of Records

Water-quality data for surface-water sites are grouped into one of three classifications. A *continuous-record station* is a site where data are collected on a regularly scheduled basis. Frequency may be one or more times daily, weekly, monthly, or quarterly. A *partial-record station* is a site where limited water-quality data are collected systematically over a period of years. Frequency of sampling is usually less than quarterly. A *miscellaneous sampling site* is a location other than a continuous- or partial-record station, where samples are collected to give better areal coverage to define water-quality conditions in the river basin.

A careful distinction needs to be made between *continuous records* as used in this report and *continuous recordings* that refer to a continuous graph or a series of discrete values recorded at short intervals. Some records of water quality, such as temperature and specific conductance, may be obtained through continuous recordings; however, because of costs, most data are obtained only monthly or less frequently.

Accuracy of the Records

One of four accuracy classifications is applied for measured physical properties at continuous-record stations on a scale ranging from poor to excellent. The accuracy rating is based on data values recorded before any shifts or corrections are made. Additional consideration also is given to the amount of publishable record and to the amount of data that have been corrected or shifted.

Rating classifications for continuous water-quality records

[≤, less than or equal to; ±, plus or minus value shown; °C, degree Celsius; >, greater than; %, percent; mg/L, milligram per liter; pH unit, standard pH unit]

Measured physical property	Rating			
	Excellent	**Good**	**Fair**	**Poor**
Water temperature	≤ ±0.2 °C	> ±0.2 to 0.5 °C	> ±0.5 to 0.8 °C	> ±0.8 °C
Specific conductance	≤ ±3%	> ±3 to 10%	> ±10 to 15%	> ±15%
Dissolved oxygen	≤ ±0.3 mg/L	> ±0.3 to 0.5 mg/L	> ±0.5 to 0.8 mg/L	> ±0.8 mg/L
pH	≤ ±0.2 unit	> ±0.2 to 0.5 unit	> ±0.5 to 0.8 unit	> ±0.8 unit
Turbidity	≤ ±5%	> ±5 to 10%	> ±10 to 15%	> ±15%

Arrangement of Records

Water-quality records collected at a surface-water daily record station are published immediately following that record, regardless of the frequency of sample collection. Station number and name are the same for both records. Where a surface-water daily record station is not available or where the water quality differs significantly from that at the nearby surface-water station, the continuing water-quality record is published with its own station number and name in the regular downstream-order sequence. Water-quality data for partial-record stations and for miscellaneous sampling sites appear in separate tables following the table of discharge measurements at miscellaneous sites.

On-Site Measurements and Sample Collection

In obtaining water-quality data, a major concern is assuring that the data obtained represent the naturally occurring quality of the water. To ensure this, certain measurements, such as water temperature, pH, and dissolved oxygen, must be made on site when the samples are taken. To assure that measurements made in the laboratory also represent the naturally occurring water, carefully prescribed procedures must be followed in collecting the samples, in treating the samples to prevent changes in quality pending analysis, and in shipping the samples to the laboratory.

Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRIs Book 1, Chapter D2; Book 3, Chapters A1, A3, and A4; and Book 9, Chapters A1-A9. Most of the methods used for collecting and analyzing water samples are described in the TWRIs, which may be accessed from *http://water.usgs.gov/pubs/twri/*. Also, detailed information on collecting, treating, and shipping samples can be obtained from the FISC-WRS (see address that is shown on the back of title page in this report).

Water Temperature

Water temperatures are measured at most of the water-quality stations. In addition, water temperatures are taken at the time of discharge measurements for water-discharge stations. For stations where water temperatures are taken manually once or twice daily, the water temperatures are taken at about the same time each day. Large streams have a small diurnal temperature change; shallow streams may have a daily range of several degrees and may follow closely the changes in air temperature. Some streams may be affected by waste-heat discharges.

At stations where recording instruments are used, either mean temperatures or maximum and minimum temperatures for each day are published. Water temperatures measured at the time of water-discharge measurements are on file in the FISC-WRS office. (see address that is shown on the back of title page in this report).

Sediment

Suspended-sediment concentrations are determined from samples collected by using depth-integrating samplers. Samples usually are obtained at several verticals in the cross section, or a single sample may be obtained at a fixed point and a coefficient applied to determine the mean concentration in the cross section.

During periods of rapidly changing flow or rapidly changing concentration, samples may be collected more frequently (twice daily or, in some instances, hourly). The published sediment discharges for days of rapidly changing flow or concentration were computed by the subdivided-day method (time-discharge weighted average). Therefore, for those days when the published sediment discharge value differs from the value computed as the product of discharge times mean concentration times 0.0027, the reader can assume that the sediment discharge for that day was computed by the subdivided-day method. For periods when no samples were collected, daily discharges of suspended sediment were estimated on the basis of water discharge, sediment concentrations observed immediately before and after the periods, and suspended-sediment loads for other periods of similar discharge.

At other stations, suspended-sediment samples are collected periodically at many verticals in the stream cross section. Although data collected periodically may represent conditions only at the time of observation, such data are useful in establishing seasonal relations between quality and streamflow and in predicting long-term sediment-discharge characteristics of the stream.

In addition to the records of suspended-sediment discharge, records of the periodic measurements of the particle-size distribution of the suspended sediment and bed material are included for some stations.

Laboratory Measurements

Samples for biochemical oxygen demand (BOD) and indicator bacteria are analyzed locally. All other samples are analyzed in the USGS laboratory in Lakewood, Colorado, unless otherwise noted. Methods used in analyzing sediment samples and computing sediment records are given in TWRI, Book 5, Chapter C1. Methods used by the USGS laboratories are given in the TWRIs, Book 1, Chapter D2; Book 3, Chapter C2; and Book 5, Chapters A1, A3, and A4. The TWRI publications may be accessed from *http://water.usgs.gov/pubs/twri/*. These methods are consistent with ASTM standards and generally follow ISO standards.

Data Presentation

For continuing-record stations, information pertinent to the history of station operation is provided in descriptive headings preceding the tabular data. These descriptive headings give details regarding location, drainage area, period of record, type of data available, instrumentation, general remarks, cooperation, and extremes for parameters currently measured daily. Tables of chemical, physical, biological, radiochemical data, and so forth, obtained at a frequency less than daily are presented first. Tables of “daily values” of specific conductance, pH, water temperature, dissolved oxygen, and suspended sediment then follow in sequence.

In the descriptive headings, if the location is identical to that of the discharge gaging station, neither the LOCATION nor the DRAINAGE AREA statements are repeated. The following information is provided with each continuous-record station. Comments that follow clarify information presented under the various headings of the station description.

LOCATION.—See Data Presentation information in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

DRAINAGE AREA.—See Data Presentation information in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

PERIOD OF RECORD.—This indicates the time periods for which published water-quality records for the station are available. The periods are shown separately for records of parameters measured daily or continuously and those measured less than daily. For those measured daily or continuously, periods of record are given for the parameters individually.

INSTRUMENTATION.—Information on instrumentation is given only if a water-quality monitor temperature record, sediment pumping sampler, or other sampling device is in operation at a station.

REMARKS.—Remarks provide added information pertinent to the collection, analysis, or computation of the records.

COOPERATION.—Records provided by a cooperating organization or obtained for the USGS by a cooperating organization are identified here.

EXTREMES.—Maximums and minimums are given only for parameters measured daily or more frequently. For parameters measured weekly or less frequently, true maximums or minimums may not have been obtained. Extremes, when given, are provided for both the period of record and for the current water year.

REVISIONS.—Records are revised if errors in published water-quality records are discovered. Appropriate updates are made in the USGS distributed data system, NWIS, and subsequently to its Web-based National data system, NWISWeb (*http://waterdata.usgs.gov/nwis*). Users of USGS water-quality data are encouraged to obtain all required data from NWIS or NWISWeb to ensure that they have the most recent updates. Updates to the NWISWeb are made on an annual basis.

The surface-water-quality records for partial-record stations and miscellaneous sampling sites are published in separate tables following the table of discharge measurements at miscellaneous sites. No descriptive statements are given for these records. Each station is published with its own station number and name in the regular downstream-order sequence.

Remark Codes

The following remark codes may appear with the water-quality data in this section:

Printed Output	Remark
E	Value is estimated.
>	Actual value is known to be greater than the value shown.
<	Actual value is known to be less than the value shown.
M	Presence of material verified, but not quantified.
N	Presumptive evidence of presence of material.
U	Material specifically analyzed for, but not detected.
A	Value is an average.

Water-Quality Control Data

The USGS National Water Quality Laboratory collects quality-control data on a continuing basis to evaluate selected analytical methods to determine long-term method detection levels (LT-MDLs) and laboratory reporting levels (LRLs). These values are re-evaluated each year on the basis of the most recent quality-control data and, consequently, may change from year to year.

This reporting procedure limits the occurrence of false positive error. Falsely reporting a concentration greater than the LT-MDL for a sample in which the analyte is not present is 1 percent or less. Application of the LRL limits the occurrence of false negative error. The chance of falsely reporting a non-detection for a sample in which the analyte is present at a concentration equal to or greater than the LRL is 1 percent or less.

Accordingly, concentrations are reported as less than LRL for samples in which the analyte was either not detected or did not pass identification. Analytes detected at concentrations between the LT-MDL and the LRL and that pass identification criteria are estimated. Estimated concentrations will be noted with a remark code of “E.” These data should be used with the understanding that their uncertainty is greater than that of data reported without the E remark code.

Data generated from quality-control (QC) samples are a requisite for evaluating the quality of the sampling and processing techniques as well as data from the actual samples themselves. Without QC data, environmental sample data cannot be adequately interpreted because the errors associated with the sample data are unknown. The various types of QC samples collected by this office are described in the following section. Procedures have been established for the storage of water-quality-control data within the USGS. These procedures allow for storage of all derived QC data and are identified so that they can be related to corresponding environmental samples. These data are not presented in this report but are available from the FISC-WRS. (see address that is shown on the back of the title page of this report).

Blank Samples

Blank samples are collected and analyzed to ensure that environmental samples have not been contaminated in the overall data-collection process. The blank solution used to develop specific types of blank samples is a solution that is free of the analytes of interest. Any measured value signal in a blank sample for an analyte (a specific component measured in a chemical analysis) that was absent in the blank solution is believed to be due to contamination. Many types of blank samples are possible; each is designed to segregate a different part of the overall data-collection process. The types of blank samples collected in this area are:

Field blank—A blank solution that is subjected to all aspects of sample collection, field processing preservation, transportation, and laboratory handling as an environmental sample.

Trip blank—A blank solution that is put in the same type of bottle used for an environmental sample and kept with the set of sample bottles before and after sample collection.

Equipment blank—A blank solution that is processed through all equipment used for collecting and processing an environmental sample (similar to a field blank but normally done in the more controlled conditions of the office).

Sampler blank—A blank solution that is poured or pumped through the same field sampler used for collecting an environmental sample.

Filter blank—A blank solution that is filtered in the same manner and through the same filter apparatus used for an environmental sample.

Splitter blank—A blank solution that is mixed and separated using a field splitter in the same manner and through the same apparatus used for an environmental sample.

Preservation blank—A blank solution that is treated with the sampler preservatives used for an environmental sample.

Reference Samples

Reference material is a solution or material prepared by a laboratory. The reference material composition is certified for one or more properties so that it can be used to assess a measurement method. Samples of reference material are submitted for analysis to ensure that an analytical method is accurate for the known properties of the reference material. Generally, the selected reference material properties are similar to the environmental sample properties.

Replicate Samples

Replicate samples are a set of environmental samples collected in a manner such that the samples are thought to be essentially identical in composition. Replicate is the general case for which a duplicate is the special case consisting of two samples. Replicate samples are collected and analyzed to establish the amount of variability in the data contributed by some part of the collection and analytical process. Many types of replicate samples are possible, each of which may yield slightly different results in a dynamic hydrologic setting, such as a flowing stream. The types of replicate samples collected in this district are:

Concurrent samples—A type of replicate sample in which the samples are collected simultaneously with two or more samplers or by using one sampler and alternating the collection of samples into two or more compositing containers.

Sequential samples—A type of replicate sample in which the samples are collected one after the other, typically over a short time.

Split sample—A type of replicate sample in which a sample is split into subsamples, each subsample contemporaneous in time and space.

Spike Samples

Spike samples are samples to which known quantities of a solution with one or more well-established analyte concentrations have been added. These samples are analyzed to determine the extent of matrix interference or degradation on the analyte concentration during sample processing and analysis.

EXPLANATION OF GROUND-WATER LEVEL RECORDS

Generally, only ground-water level data from selected wells with continuous record from a basic network of observation wells are published in this report. This basic network contains observation wells located so that the most significant data are obtained from the fewest wells in the most important aquifers.

Site Identification Numbers

Each well is identified by means of (1) a 15-digit number that is based on latitude and longitude and (2) a local number that is produced for local needs. (See NUMBERING SYSTEM FOR WELLS AND MISCELLANEOUS SITES in this report for a detailed explanation).

Data Collection and Computation

Measurements are made in many types of wells, under varying conditions of access and at different temperatures; hence, neither the method of measurement nor the equipment can be standardized. At each observation well, however, the equipment and techniques used are those that will ensure that measurements at each well are consistent.

Most methods for collecting and analyzing water samples are described in the TWRIs referred to in the On-site Measurements and Sample Collection and the Laboratory Measurements sections in this report. In addition, TWRI Book 1, Chapter D2, describes guidelines for the collection and field analysis of ground-water samples for selected unstable constituents. Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRIs Book 1, Chapter D2; Book 3, Chapters A1, A3, and A4; and Book 9, Chapters A1 through A9. The TWRI publications may be accessed from *http://water.usgs.gov/pubs/twri/*. The values in this report represent water-quality conditions at the time of sampling, as much as possible, and that are consistent with available sampling techniques and methods of analysis. These methods are consistent with ASTM standards and generally follow ISO standards. Trained personnel collected all samples. Most of the wells sampled were pumped long enough to ensure that the water collected came directly from the aquifer and had not stood for a long time in the well casing where it would have been exposed to the atmosphere and to the material, possibly metal, comprising the casings. Wells that have very long open intervals (generally 20 ft or greater) , were sampled using a down hole sampling device that collects a water sample from the bottom of the well.

Water-level measurements in this report are given in feet with reference to land-surface datum, elevation described in feet above or below National Geodetic Vertical Datum of 1929 (NGVD 29), unless otherwise noted. The elevation of the land-surface datum (lsd) above sea level is also given in the well description. Land-surface datum is a datum plane that is approximately at land surface at each well. The height of the measuring point (MP) above or below land-surface datum is given in each well description. Water levels in wells equipped with recording gages are reported for every fifth day and the end of each month (EOM).

Water levels are reported to as many significant figures as can be justified by the local conditions. For example, in a measurement of a depth of water of several hundred feet, the error in determining the absolute value of the total depth to water may be a few tenths of a foot, whereas the error in determining the net change of water level between successive measurements may be only a hundredth or a few hundredths of a foot. For lesser depths to water the accuracy is greater. Accordingly, most measurements are reported to a hundredth of a foot, but some are given only to a tenth of a foot or a larger unit.

Accuracy of Ground-Water Level Data

A number of factors affect the accuracy of the ground-water level data published in this report. These factors can be logically separated into those that are related to ground-water level measurement methods (Method-Related Factors) and those that are independent of the methods.

Method-Independent Factors

Water levels are determined using a specific measuring point (MP) at each well. The elevation of this point for most wells published in this report was determined relative to the National Geodetic Vertical Datum of 1929 (NGVD 1929). Scientific advances in determining vertical elevations have caused the development of the North American Vertical Datum of 1988 (NAVD 1988). The National Geodetic Survey (NGS) has completed an extensive releveling effort that provides elevations referenced to NAVD 1988. The U.S. Geological Survey is currently considering how best to utilize the newer NAVD 1988 and yet maintain the continuity of data in south Florida.

Some stations in this report have been surveyed using a benchmark elevation surveyed in NAVD 1988. In an attempt to publish the elevation of each station within the hydrologic monitoring network in the same datum plane, the elevation of the NAVD 1988 benchmark was converted using the VERTCON or CORPSCON software of the National Geodetic Survey to provide a reference elevation in NGVD 1929. The NGVD 1929 datum determined using VERTCON or CORPSCON is known to differ from the historic NGVD 1929 elevation datum (historic NGVD). Hydrologic model development for some sites has required publication of data in the NAVD 1988 datum. The datum of each station is clearly defined in the DATUM or GAGE section of each station manuscript.

Water levels in wells open to highly transmissive aquifers may be affected by barometric pressure. The water-level data in this publication have not been adjusted for barometric pressure effects. Water levels may also be affected by density differences. For example highly saline water has a greater density than fresh water. Water levels have not been adjusted for density effects.

Method-Related Factors

Water-level data are collected using a number of different methods. Each method has inherent factors that affect the accuracy of measured water levels.

STEEL TAPE AND CHALK -- This generally is the most accurate method of measuring the elevation difference between a reference point and the water level in a ground-water well. When the water level is measured using this method, at least two separate measurements are performed. These measurements must agree to within 0.02 ft before the average value is recorded. The precision of this method, is $\pm$ 0.02 ft.

PRESSURE GAGE -- Wells under artesian pressure are monitored using a mechanical pressure gage. These pressure gages are graduated to 0.2 ft. Gages are periodically checked using a pressure manifold to compare gage readings over a range of known pressures. Corrections are applied to the gage readings based on these checks. The reported value is estimated to the nearest tenth of a foot. The precision of this method should be considered to be about $\pm$ 0.1 ft.

FLOAT AND RECORDER -- The accuracy of data recorded using this method is affected by friction within the recorder system as well as friction between the float and the well casing. In large-diameter wells (6 in. or greater), where large floats are used, these effects are minimal; however in small-diameter wells (2 to 6 in.) these effects can be substantial. Friction might significantly affect the data where water-surface fluctuations are very small. Every effort has been made to reduce frictional effects to a minimum.

The accuracy of this method may also be affected by slippage of the float tape or wire, leaks in the float, or biological factors (for example, amphibians crawling on the float). The accuracy of the recorder reading is periodically verified using steel tape and chalk measurements. When the difference between these tape measurements and the recorded value is 0.05 ft or greater, the recorder is reset and a gage-height correction is applied to the data. Uncertainty in water levels for wells verified by steel tape measurements is generally no greater than $\pm$ 0.05 ft.

PRESSURE TRANSDUCER AND RECORDER -- In wells where artesian pressure, frictional effects, or an extensive range in water levels have made float and recorder systems infeasible, pressure transducers have been installed. Transducers are selected that meet or exceed the float and recorder system accuracy. Water levels may be verified using either steel tape or pressure gage measurements. Uncertainty in those verified by steel-tape measurements is generally considered to be no greater than $\pm$ 0.05 ft and uncertainty for those verified using pressure gage readings is generally considered to be about $\pm$ 0.1 ft.

The type of method used to collect water-level data is identified in the INSTRUMENTATION section of each station manuscript.

Data Presentation

Water-level data are presented in alphabetical order by county. The primary identification number for a given well is the 15-digit site identification number that appears in the upper left corner of the table. The secondary identification number is the local or county well number. Well locations are shown in figures for each county, each well is identified on the map by an index number that is cross-referenced to its identification number in a location key preceding the map.

Each well record consists of three parts: the well description, the data table of water levels observed during the water year, and, for most wells, a hydrograph following the data table. Well descriptions are presented in the headings preceding the tabular data.

The following comments clarify information presented in these various headings.

LOCATION.—This paragraph follows the well-identification number and reports the hydrologic-unit number and a geographic point of reference. Latitudes and longitudes used in this report are reported as North American Datum of 1927 unless otherwise specified.

AQUIFER.—This entry designates by name and geologic age the aquifer that the well taps.

WELL CHARACTERISTICS.—This entry describes the well in terms of depth, casing diameter and depth or screened interval, method of construction, use, and changes since construction.

INSTRUMENTATION.—This paragraph provides information on both the frequency of measurement and the collection method used, allowing the user to better evaluate the reported water-level extremes by knowing whether they are based on continuous, monthly, or some other frequency of measurement.

DATUM.—This entry describes the measuring point. The measuring point is described physically (such as top of casing, top of instrument shelf, and so forth).

LAND-SURFACE DATUM.—This is a new section started for water year 2003, to document land-surface datum. The elevation of the land-surface datum is described in feet above National Geodetic Vertical Datum of 1929 (NGVD 29), unless otherwise noted; it is reported with a precision depending on the method of determination.

REMARKS.—This entry describes factors that may influence the water level in a well or the measurement of the water level, when various methods of measurement were begun, and the network (climatic, terrane, local, or areal effects) or the special project to which the well belongs.

PERIOD OF RECORD.—This entry indicates the time period for which records are published for the well, the month and year at the start of publication of water-level records by the USGS, and the words “to current year” if the records are to be continued into the following year. Time periods for which water-level records are available, but are not published by the USGS, may be noted.

EXTREMES FOR PERIOD OF RECORD.—This entry contains the highest and lowest instantaneously recorded or measured water levels of the period of published record, with respect to land-surface datum or sea level, and the dates of occurrence.

Water-Level Tables

A table of water levels follows the well description for each well. Water-level measurements in this report are given in feet with reference to either sea level or land-surface datum (lsd). Missing records are indicated by dashes in place of the water-level value.

For wells not equipped with recorders, water-level measurements were obtained periodically by steel or electric tape or pressure gage. Tables of periodic water-level measurements in these wells show the date of measurement and the measured water-level value.

Hydrographs

Hydrographs are a graphic display of water-level fluctuations over a period of time. In this report, current water year and, when appropriate, period-of-record hydrographs are shown. Hydrographs that display periodic water-level measurements show points that may be connected with a dashed line from one measurement to the next. Hydrographs that display recorder data show a solid line representing the mean water level recorded for each day. Missing data are indicated by a blank space or break in a hydrograph. Missing data may occur as a result of recorder malfunctions, battery failures, or mechanical problems related to the response of the recorder’s float mechanism to water-level fluctuations in a well.

RECORDS OF BULK ELECTRICAL CONDUCTIVITY

Bulk electrical conductivity is the combined electrical conductivity of all material (including pore water) within an approximately 8- to 40-inch doughnut-shaped area surrounding an electromagnetic induction probe (McNeill and others, 1990). Bulk electrical conductivity is affected by different physical and chemical properties of the material including the dissolved-solids concentration of the pore water, and the lithology and porosity of the rock. Polyvinyl chloride (PVC) casings do not interfere with these measurements; however, for those wells where a steel or galvanized iron casing extends part way down the well, the probe cannot sense the materials outside of the casing. As the probe is lowered down the well and out of the influence of a metallic casing, a spike is usually created in the data. Metal well centralizers can also affect the data collected and can cause very large spikes in the data at the depths where the centralizers are installed. These spikes are much different than the changes in bulk electromagnetic conductivity caused by natural lithologic or pore water variations and as such are readily recognizable. As the probe passes through different layers of rock, the different physical properties will cause variation in the recorded conductivity values. A clean sand or sandstone will generally produce lower conductivity values than clay or mudstone. Although the properties of the rocks or well construction will remain constant from year to year, those of the pore water may change due to saltwater intrusion. Conductivity values from freshwater-saturated rocks typically are less than 25 mS/m, whereas conductivity values from saltwater-saturated rocks are typically greater than 67 mS/m (Hittle, 1999). Therefore, electromagnetic induction logging can be used to assess increases or decreases in the conductivity of pore waters caused by movement of the saltwater interface.

Data Collection and Computation

Measurements generally are made during the period of lowest aquifer water levels, in April of each year. However, some wells may have additional logs. During periods of decreased water levels, saltwater intrusion into a freshwater aquifer is likely to be at a maximum. In wells where saltwater is detectable, the graphic representation of data from successive years will show any vertical movement of the saltwater-freshwater interface. Measuring this vertical movement of the interface is the primary use of the bulk electrical conductivity logs published in this report. Upward movement of the interface between freshwater and saltwater in a monitoring well indicates that saltwater intrusion is increasing in that area. Downward movement of the interface indicates recession of the saltwater front near the monitoring well.

In the bulk electrical conductivity graphs of some of the wells logged for this report, the interface position can be seen as the point where low values of conductivity increase suddenly to values generally above 67 mS/m (usually near the bottom of the well). However, the interface position is not as apparent in other wells, and in some, there is no interface. Some locations have been identified where saltwater contamination of the aquifer is occurring above the base of the aquifer as a result of seepage of saline from canals. The bulk electrical conductivity logs detect the changes in fluid conductivity that occur as a result of this seepage.

In wells selected for electromagnetic induction logging, a water sample may be collected and analyzed as a check of the level of salinity. Because bulk electrical conductivity is a function of fluid conductivity, lithology, and porosity, the relationship between the electromagnetic induction logs and the chloride samples may not be as obvious as is the general relationship between fluid conductivity and chloride concentrations. If the rock is not very porous, then the change in bulk electrical conductivity caused by changes in the salinity of the pore water may be smaller than might be expected. Nonetheless, the long-term changes in the bulk electrical conductivity logs are sufficient to assess upward or downward movement of the interface. To aid in interpretation of the bulk electrical conductivity logs, the chloride concentration is shown on the graph of bulk electrical conductivity if water samples have been collected.

The instrument used to collect data for this report is calibrated prior to each field session. The calibration procedure establishes a mathematical constant (calibration factor) that is used to convert raw instrument readings in counts per second (cps) into values of bulk electrical conductivity in millisiemens per meter (mS/m). When data were graphed for the 2000 annual water resources data report, offsets and amplitude differentials occurred in the calibrated values of bulk electrical conductivity for each well between successive years. Investigation revealed that some of the observed offsets and amplitude differentials were caused by differing calibration factors between years. Most calibration factors differed because of temperature and humidity differences during calibration. The calibration procedures adopted during the 2000 water year were designed to minimize the influence of variable temperature and humidity. Before calibrating, the electromagnetic induction probe was lowered into a well and allowed to equilibrate in the water column. The probe was then removed from the well and the instrument immediately calibrated.

Factors other than variable temperature and humidity also have caused offsets and amplitude differentials. One such example occurred with data collected for the 2000 water year. Prior to logging for the 2000 water year, the instrument firmware and software was updated. After logging, it was found that the data had been truncated at the decimal point. Errors in calibration have also been identified and corrected (see Accuracy of Bulk Electrical Conductivity).

Accuracy of Bulk Electrical Conductivity

There are two components that affect the quality of the electromagnetic induction logs published in this report: (1) vertical or depth accuracy, and (2) accuracy and precision of measured bulk electrical conductivity. Vertical accuracy, which affects the determined interface position, is the most critical factor in this monitoring effort. A quality control program sets the velocity of the probe at 12 ft/min (feet per minute) while logging. Before logging begins, a spot on the probe, 3.32 feet above the sensing head, is aligned with the measuring point of the well. Where possible, the data recorded as the probe was moved up the well were used to produce the graphs for this report. Depth values from successive water years were adjusted, if needed, to coincide at one or more specific conductivity peak recorded from an upper part of the well. Depth values were interpolated to the nearest tenth of a foot. The precision of depth determinations using this reporting method should be considered to be about ±0.1 foot.

The accuracy and precision of measured bulk electrical conductivity are a function of both the inherent accuracy of the electromagnetic induction probe and its calibration. The inherent precision of the probe is considered by the manufacturer to be ±5 percent of the full scale. For the logs collected, the electromagnetic induction probe was set to a full scale of 1,000 mS/m. This translates into a precision of ±50 mS/m at full scale. Analysis indicated that the offsets caused by the effects of temperature and humidity on calibration were generally within this range.

In the 1998 water year and for all water years after 2001, the electromagnetic induction probe was calibrated using standards of 0 and 345 mS/m. There are a number of monitoring wells where the measured bulk electrical conductivity exceeds 345 mS/m. For these wells, a calibration standard of 345 mS/m was still used. This is because the probe would have to be set to a full scale of 10,000 mS/m in order to be calibrated using the next available standard (1,301 mS/m). This value would greatly exceed the normal range in bulk electrical conductivity expected. The 345 mS/m calibration constant was also considered to be acceptable because within the range 0 to 1,000 mS/m, the response of the probe is considered to be linear; therefore calibrating the probe to this standard should not significantly reduce accuracy.

In the water years prior to 2002 (excluding 1998), the electromagnetic induction probe generally was calibrated using a 1,301 mS/m standard even though the full scale of the probe was 1,000 mS/m. This caused a calibration error in the data collected. To correct this error, a multiplier of 0.7686 was applied to all of the affected data.

Accuracy of data collected during the 2000 water year may have been affected by the firmware or software update in December 1999. The data collected using this new software and firmware was considerably offset relative to previous electromagnetic induction logs. In addition, the final values were truncated at the decimal point, whereas those collected prior to the update were recorded to the thousandths decimal place. These final values are the result of a multiplication of the raw data from the instrument and a calibration factor. It is unknown whether or not the raw values were truncated at the decimal point. If so, the resulting error could be on the order of 5 mS/m too low. Because the offset data from the 2000 water year are often 5 mS/m lower than the data from other years, truncation of the raw data probably is the explanation.

Data Presentation

Records of conductivity are published individually on the page immediately following the well manuscript. Data for conductivity are identified by well number. Each record consists of a single graph representing conductivity, a lithologic log, and a brief explanation.

RECORDS OF GROUND-WATER QUALITY

Records of ground-water quality in this report differ from other types of records in that, for the salinity network sites, they consist of a limited set of measurements for the water year. The quality of ground water ordinarily changes slowly; therefore, for most general purposes, a small number of samples except for a few samples taken seasonally during the year, is sufficient. Frequent measurement of the same constituents is not necessary unless one is concerned with a particular problem, such as monitoring for saltwater intrusion. In the special cases where the quality of ground water may change more rapidly, more frequent measurements are made to identify the nature of the changes.

Data Collection and Computation

The ground-water-quality data in this report were obtained mostly as a part of the Florida Integrated Science Center, Center for Water and Restoration Studies salinity network or as a part of special studies in specific areas. Consequently, a number of chemical analyses are presented for some wells within a county but not for others. As a result, the records for this year, by themselves, do not provide a balanced view of ground-water quality in the report area. Such a view can be attained only by considering records for this year in context with similar records obtained for these and other counties in earlier years.

Most methods for collecting and analyzing water samples are described in the U.S. Geological Survey National Field Manual for the collection of Water-Quality Data and the "Laboratory Measurements" sections in this data report and are also described in the TWRIs, which may be accessed from *http://water.usgs.gov/pubs/twri/*. Procedures for on-site measurements and for collecting, treating, and shipping samples are given in TWRI, Book 1, Chapter D2; Book 5, Chapters A1, A3, and A4 and Book 9, Chapters A1-A6. Also, detailed information on collecting, treating, and shipping samples may be obtained from the FISC-WRS office. (See address that is shown on the back of the title page of this report.)

The values reported in this report represent water-quality conditions at the time of sampling as much as possible, consistent with available sampling techniques and methods of analysis. These methods are consistent with ASTM standards and generally follow ISO standards. All samples were obtained by trained personnel. The wells sampled were pumped long enough to assure that the water collected came directly from the aquifer and had not stood for a long time in the well casing where it would have been exposed to the atmosphere and to the material, possibly metal, comprising the casings.

Laboratory Measurements

Analysis for sulfide and measurement of alkalinity, pH, water temperature, specific conductance, and dissolved oxygen are performed on site. All other sample analyses are performed at the USGS laboratory in Lakewood, Colorado, unless otherwise noted. Methods used by the USGS laboratory are given in TWRI, Book 1, Chapter D2; and Book 5, Chapters A1, A3, and A4, which may be accessed from *http://water.usgs.gov/pubs/twri/*.

Data Presentation

The records of ground-water quality are published immediately following the ground-water level records of each county. Data for quality of ground water are identified by well number. The prime identification number for wells sampled is the 15-digit number derived from the latitude-longitude locations. The Remark Codes listed for surface-water-quality records are also applicable to ground-water-quality records.

ACCESS TO USGS WATER DATA

The USGS provides near real-time stage and discharge data for many of the gaging stations equipped with the necessary telemetry and historic daily mean and peak-flow discharge data for most current or discontinued gaging stations through the World Wide Web (WWW). These data may be accessed from *http://water.usgs.gov*.

Water-quality data and ground-water data also are available through the WWW. In addition, data can be provided in various machine-readable formats on various media. Information about the availability of specific types of data or products, and user charges, can be obtained locally from each Water Discipline Office (See address that is shown on the back of the title page of this report.)

DEFINITION OF TERMS

Specialized technical terms related to streamflow, water-quality, and other hydrologic data, as used in this report, may be accessed from *http://water.usgs.gov/ADR_Defs_2004.pdf*. Terms such as algae, water level, and precipitation are used in their common everyday meanings, definitions of which are given in standard dictionaries. Not all terms defined in this alphabetical list apply to every State. See also table for converting English units to International System (SI) Units. Other glossaries that also define water-related terms are accessible from *http://water.usgs.gov/glossaries.html*.

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